TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE

TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE

1896

VOL. XXIX.

(TWELFTH OF NEW SERIES)

EDITED AND PUBLISHED UNDER THE AUTHORITY OF THE BOARD OF GOVERNORS OF THE INSTITUTE

BY

SIR JAMES HECTOR, K.C.M.G., M.D., F.R.S.
DIRECTOR

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NEW ZEALAND INSTITUTE.

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND INTITULED "THE NEW ZEALAND INSTITUTE ACT, 1867."

BOARD OF GOVERNORS.

(EX OFFICIO.)

His Excellency the Governor.
The Hon. the Colonial Secretary.

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W. T. L. Travers, F.L.S.; Sir James Hector, K.C.M.G., M.D., F.R.S.; W. M. Maskell; Thomas Mason; E. Tregear, F.R.G.S.; John Young.

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1896.—James McKerrow, F.R.A.S., S. Percy Smith, F.R.G.S.; Major-General Schaw, C.B., R.E.

MANAGER: Sir James Hector.

HONORARY TREASURER: W. T. L. Travers, F.L.S.

SECRETARY: R. B. Gore.

ABSTRACTS OF RULES AND STATUTES.

GAZETTED IN THE "NEW ZEALAND GAZETTE," 9TH MARCH, 1868.

SECTION I.

Incorporation of Societies.

1. No society shall be incorporated with the Institute under the provisions of "The New Zealand Institute Act, 1867," unless such society shall consist of not less than twenty-five members, subscribing in the aggregate a sum of not less than fifty pounds sterling annually for the promotion of art, science, or such other branch of knowledge for

which it is associated, to be from time to time certified to the satisfaction of the Board of Governors of the Institute by the Chairman for the time being of the society.

2. Any society incorporated as aforesaid shall cease to be incorporated with the Institute in case the number of the members of the said society shall at any time become less than twenty five, or the amount of money annually subscribed by such members shall at any time be less than £50.

3. The by-laws of every society to be incorporated as aforesaid shall provide for the expenditure of not less than one third of the annual revenue in or towards the formation or support of some local public museum or library, or otherwise shall provide for the contribution of not less than one-sixth of its said revenue towards the extension and maintenance of the Museum and library of the New Zealand Institute.

4 Any society incorporated as aforesaid, which shall in any one year fail to expend the proportion of revenue affixed in manner provided by Rule 3 aforesaid, shall from thenceforth cease to be incorporated with the Institute.

5. All papers read before any society for the time being incorporated with the Institute shall be deemed to be communications to the Institute, and may then be published as Proceedings or Transactions of the Institute, subject to the following regulations of the Board of the Institute regarding publications:—

Regulations regarding Publications.

(*a.*) The publications of the Institute shall consist of a current abstract of the proceedings of the societies for the time being incorporated with the Institute, to be intituled "Proceedings of the New Zealand Institute," and of transactions, comprising papers read before the incorporated societies (subject, however, to selection as hereinafter mentioned), to be intituled "Transactions of the New Zealand Institute."

(*b.*) The Institute shall have power to reject any papers read before any of the incorporated societies.

(*c.*) Papers so rejected will be returned to the society in which they were read.

(*d.*) A proportional contribution may be required from each society towards the cost of publishing the Proceedings and Transactions of the Institute.

(*e*) Each incorporated society will be entitled to receive a *proportional* number of copies of the Proceedings and Transactions of the Institute, to be from time to time fixed by the Board of Governors.

(*f.*) Extra copies will be issued to any of the members of incorporated societies at the cost-price of publication.

6. All property accumulated by or with funds derived from incorporated societies, and placed in charge of the Institute, shall be vested in the Institute, and be used and applied at the discretion of the Board of Governors for public advantage, in like manner with any other of the property of the Institute.

7. Subject to "The New Zealand Institute Act, 1867," and to the foregoing rules, all societies incorporated with the Institute shall be entitled to retain or alter their own form of constitution and the by-laws for their own management, and shall conduct their own affairs.

8. Upon application signed by the Chairman and countersigned by the Secretary of any society, accompanied by the certificate required under Rule No. 1, a certificate of incorporation will be granted under the seal of the Institute, and will remain in force as long as the foregoing rules of the Institute are complied with by the society.

SECTION II.

For the Management of the Property of the Institute.

9. All donations by societies, public departments, or private individuals to the Museum of the Institute shall be acknowledged by a printed form of receipt, and shall be duly entered in the books of the Institute provided for that purpose, and shall then be dealt with as the Board of Governors may direct.

10. Deposits of articles for the Museum may be accepted by the Institute, subject to a fortnight's notice of removal, to be given either by the owner of the articles or by the Manager of the Institute, and such deposits shall be duly entered in a separate catalogue.

11. Books relating to natural science may be deposited in the library of the Institute, subject to the following conditions:—

(*a*.) Such books are not to be withdrawn by the owner under six months' notice, if such notice shall be required by the Board of Governors.

(*b*.) Any funds especially expended on binding and preserving such deposited books at the request of the depositor shall be charged against the books, and must be refunded to the Institute before their withdrawal, always subject to special arrangements made with the Board of Governors at the time of deposit.

(*c*.) No books deposited in the library of the Institute shall be removed for temporary use except on the written authority or receipt of the owner, and then only for a period not exceeding seven days at any one time.

12. All books in the library of the Institute shall be duly entered in a catalogue, which shall be accessible to the public.

13. The public shall be admitted to the use of the Museum and library, subject to by laws to be framed by the Board.

SECTION III.

The laboratory shall for the time being be and remain under the exclusive management of the Manager of the Institute.

SECTION IV.

(OF DATE 23RD SEPTEMBER, 1870)

Honorary Members.

Whereas the rules of the societies incorporated under the New Zealand Institute Act provide for the election of honorary members of such societies, but inasmuch as such honorary members would not thereby become members of the New Zealand Institute, and whereas it is expedient to make provision for the election of honorary members of the New Zealand Institute, it is hereby declared,—

1. Each incorporated society may, in the month of November next, nominate for election, as honorary members of the New Zealand Institute, three persons, and in the month of November in each succeeding year one person, not residing in the colony.
2. The names, descriptions, and addresses of persons so nominated, together with the grounds on which their election as honorary members is recommended, shall be forthwith forwarded to the Manager of the New Zealand Institute, and shall by him be submitted to the Governors at the next-succeeding meeting.
3. From the persons so nominated the Governors may select in the first year not more than nine, and in each succeeding year not more than three, who shall from thenceforth be honorary members of the New Zealand Institute, provided that the total number of honorary members shall not exceed thirty.

LIST OF INCORPORATED SOCIETIES.

NAME OF SOCIETY.	DATE OF INCORPORATION.
Wellington Philosophical Society	10th June, 1868.
Auckland Institute	10th June, 1868.
Philosophical Institute of Canterbury	22nd Oct., 1868.
Otago Institute	18th Oct., 1869.
Westland Institute	21st Dec., 1874.
Hawke's Bay Philosophical Institute	31st Mar., 1875.
Southland Institute	21st July., 1880.
Nelson Philosophical Society	20th Dec., 1883.

OFFICERS OF INCORPORATED SOCIETIES, AND EXTRACTS FROM THE RULES.

WELLINGTON PHILOSOPHICAL SOCIETY.

Office-bearers for 1897.—*President*—W. T. L. Travers, F.L.S.; *Vice-presidents*—R. C Harding, E. Tregear, F.R.G.S.; *Council*—Sir W. L. Buller, F.R.S.; W. M. Maskell, G. V. Hudson, F.E.S.; Thomas Kirk, F.L.S.; Major-General Schaw, C.B., R.E.; Sir J. Hector, F.R.S.; R. L. Mestayer, M. Inst. C.E.; *Secretary and Treasurer*—R. B. Gore; *Auditor*—T. King.

Extracts from the Rules of the Wellington Philosophical Society.

5. Every member shall contribute annually to the funds of the Society the sum of one guinea.

6. The annual contribution shall be due on the first day of January in each year.

7. The sum of ten pounds may be paid at any time as a composition for life of the ordinary annual payment.

14. The time and place of the general meetings of members of the Society shall be fixed by the Council, and duly announced by the Secretary.

AUCKLAND INSTITUTE.

Office-bearers for 1897.—*President*—E. Roberton, M.D.; *Vice-presidents*—D. Petrie, F.L.S., Professor A. P. Thomas, F.L.S.; *Council*—G. Aickin, J. Batger, W. Berry, H. Campbell, C. Cooper, E. A. Mackechnie, T. Peacock, Rev. A. G. Purchas, M.R.C.S.E., J. Reid, J. Stewart, C.E., J. H. Upton; *Trustees*—E. A. Mackechnie, S. P. Smith, F.R.G.S., T. Peacock; *Secretary and Curator*—T. F. Cheeseman, F.L.S., F.Z.S.; *Auditor*—W. Gorrie.

Extracts from the Rules of the Auckland Institute.

1. Any person desiring to become a member of the Institute shall be proposed in writing by two members, and shall be balloted for at the next meeting of the Council.

4. New members on election to pay one guinea entrance-fee, in addition to the annual subscription of one guinea, the annual subscription being payable in advance on the first day of April for the then current year.

5. Members may at any time become life members by one payment of ten pounds ten shillings in lieu of future annual subscriptions.

10. Annual general meeting of the society on the third Monday of February in each year. Ordinary business meetings are called by the Council from time to time.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Office-bearers for 1897.—*President*—Dr. W. Thomas; *Vice-presidents*—Dr. W. P. Evans, R. Speight; *Hon. Secretary*—Professor Dendy; *Hon. Treasurer*—Captain F. W. Hutton, F.R.S.; *Council*—F. C. Binns, L. Cockayne, R. M. Laing, S. Page, Dr. W. H. Symes, and H. R. Webb; *Auditor*—R. C. Bishop.

Extracts from the Rules of the Philosophical Institute of Canterbury.

8. Members of the Institute shall pay one guinea annually as a subscription to the funds of the Institute. The subscription shall be due on the 1st November in each year.

The Institute may also admit associates, who shall contribute five shillings annually to the funds of the Institute, and shall have all the privileges of members, except that they shall not have the power to vote, or be entitled to the annual volume of the Transactions.

9. Members may compound for all annual subscriptions of the current and future years by paying ten guineas.

15. The ordinary meetings of the Institute shall be held on the first Wednesday in each month during the months of May to October, both inclusive.

OTAGO INSTITUTE.

Office-bearers for 1897.—*President*—J. R. Don, D.Sc.; *Vice-presidents*—A. Hamilton and Professor Shand, LL.D.; *Hon. Secretary*—Professor Parker, F.R.S.; *Hon. Treasurer*—J. S. Tennant, B.Sc.; *Council*—G. M. Thomson, F.L.S., Professor Scott, M.D., A. Wilson, M.A., F. R. Chapman, E. Melland, T. M. Hocken, F.L.S., A. Bathgate; *Auditor*—D. Brent, M.A.

Extracts from the Constitution and Rules of the Otago Institute.

2. Any person desiring to join the society may be elected by ballot, on being proposed in writing at any meeting of the Council or society by two members, and on the payment of the annual subscription of one guinea for the year then current.

5. Members may at any time become life-members by one payment of ten pounds and ten shillings in lieu of future annual subscriptions.

8. An annual general meeting of the members of the society shall be held in January in each year, at which meeting not less than ten members must be present, otherwise the meeting shall be adjourned by the members present from time to time until the requisite number of members is present.

(5.) The session of the Otago Institute shall be during the winter months, from May to October, both inclusive.

WESTLAND INSTITUTE.

OFFICE-BEARERS FOR 1897.—*President*—A. H. King; *Vice-president*—D. Macfarlane; *Hon. Treasurer*—T. H. Gill; *Trustees*—Messrs. Chesney, Clarke, Beare, Dawes, Fowler, Gibson, Heinz, Lawry, Mahan, Michel, Sinclair, and Rev. S Hamilton.

Extracts from the Rules of the Westland Institute.

3. The Institute shall consist (1) of life-members—*i.e.*, persons who have at any one time made a donation to the Institute of ten pounds ten shillings or upwards, or persons who, in reward of special services rendered to the Institute, have been unanimously elected as such by the Committee or at the general half-yearly meeting; (2) of members who pay two pounds two shillings each year; (3) of members paying smaller sums, not less than ten shillings.

5. The Institute shall hold a half-yearly meeting on the third Monday in the months of December and June.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

OFFICE-BEARERS FOR 1897.—*President*—Dr. T. C. Moore; *Vice-president*—Dr. A. Milne-Thomson; *Hon. Treasurer*—G. White; *Hon. Secretary*—W. Dinwiddie; *Council*—Messrs. Carlile, Tanner, Hill, Hislop, and Adams, and Dr. Jarvis.

Extracts from the Rules of the Hawke's Bay Philosophical Institute.

3. The annual subscription for each member shall be one guinea, payable in advance on the first day of January in every year.

4. Members may at any time become life-members by one payment of ten pounds ten shillings in lieu of future annual subscriptions.

(4.) The session of the Hawke's Bay Philosophical Institute shall be during the winter months from May to October, both inclusive; and general meetings shall be held on the second Monday in each of those six months, at 8 p.m.

SOUTHLAND INSTITUTE.

OFFICE-BEARERS.—*Trustees*—Ven. Archdeacon Stocker, Rev. John Ferguson, Dr. James Galbraith.

NELSON PHILOSOPHICAL SOCIETY.

Office-bearers for 1897.—*President*—The Bishop of Nelson; *Vice-presidents*—A. S. Atkinson, F.L.S., and Dr. W. J. Mackie; *Council*—Dr. L. Boor, E. Lukins, W. F. Worley, J. G. Bartell, and J. Holloway; *Hon. Secretary*—R. I. Kingsley; *Hon. Treasurer*—Dr. J. Hudson; *Curator*—R. I. Kingsley; *Assistant Curator*—E. Lukins.

Extracts from the Rules of the Nelson Philosophical Society

4. Members shall be elected by ballot

6. The annual subscription shall be one guinea.

7. The sum of ten guineas may be paid in composition of the annual subscription.

16. Meetings shall be held on the second Monday in every month.

23. The papers read before the Society shall be immediately delivered to the Secretary.

TRANSACTIONS

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE, 1896.

I.—MISCELLANEOUS

Art. I.—*Traces of Civilization: an Inquiry into the History of the Pacific.*

By Joshua Rutland

Communicated by E. Tregear, F.R.G.S.

[*Read before the Wellington Philosophical Society, 22nd July, 23rd September, and 11th November, 1896.*]

I.—Introduction: Cultivated Plants of New Zealand.

Ever since Nuñez de Balboa first beheld its waters from the heights of Panama, the Pacific Ocean, or Great South Sea as it was long familiarly styled, has been a region of mystery. Until Magalhaens discovered the strait that bears his name it seemed to be walled off from the Atlantic, or North Sea, and from the civilized world beyond, by an unbroken barrier of land that stretched from pole to pole. After European mariners were afloat on its surface, what lands, what continents, what islands lay within its broad expanse and around its shores, remained for centuries unknown. As the explorer and the geographer solved these questions new sources of wonder revealed themselves. Strange forms of animal and vegetable life—pouched quadrupeds, wingless birds, leafless trees—were brought to light, setting the poet rhyming and the naturalist thinking how these discoveries agreed with long-cherished beliefs they were destined to subvert.

Amongst the many curious questions to which the region has given birth, none have more completely baffled inquiry than those suggested by its human inhabitants. From whence, how, and when were its countless scattered islands peopled is still as great a mystery as when Europeans first discovered them.

In many of these islands the inhabitants, on our becoming acquainted with them, possessed various arts and had many customs in common with peoples in other distant portions of the world, besides having in cultivation a number of foreign plants, and in domestication a few foreign animals.

In addition to these traces of a civilization certainly not endemic, and probably not indigenous, scattered throughout the numerous island groups were monuments evidently of great antiquity, many of them being far beyond the constructive power of the modern inhabitants.

By following up these traces to their source it is evident we must obtain, in part at least, a reply to one or more of these questions—from whence, how, and when came the inhabitants of the islands wherein they occur?

This course of inquiry was not open to those who first speculated on the "mystery of Polynesia"; with the assistance of physical science, the conclusions arrived at by modern historians and archæologists, and the observations made by travellers and others in various parts of the globe, it may now be possible.

Of the three great periods—the Age of Stone, the Age of Bronze, and the Age of Iron—into which the history of art has been divided, the Old World, at the commencement of the sixteenth century, may be regarded as representing the Iron Age, the New World the Bronze Age, and the Pacific region, including Australasia and Polynesia, the Age of Stone. Though the inhabitants of the continent and of the countless islands scattered over the vast ocean may be thus grouped together, in other respects they differ widely. Thus, while the Australian aborigines were mere nomad hunters, the inhabitants of Polynesia and New Zealand were skilful agriculturists. To the more advanced section of the population we must chiefly look for the lost history we are seeking, and for the causes that placed all so far behind in the march of civilization. Amongst the various groups inhabited by the agricultural nations, the New Zealand Archipelago, owing to its geographical position, its size, its varied geological formation, and its climate, is the most important in the present inquiry. Had the islands been first populated by a people acquainted with the methods of obtaining and manufacturing metals, these arts, as well as those connected with agriculture, would have been preserved, notwithstanding the few cultivated plants the

inhabitants possessed when Europeans came in contact with them, all of which were ill adapted to the climatic conditions of the country. From these plants, the *aute*, *taro*, *hue*, and *kumara*, we gather that the inhabitants came from a much warmer zone, and that, between the time of their arrival in the country and its rediscovery by Cook in 1769, they were unable to obtain more suitable species. Besides the foreign plants enumerated, there were in cultivation when the missionaries commenced their labours in the country several varieties of the *Phormium tenax*, an endemic species, proving that it was not the lack of knowledge that limited agriculture.

I will now examine separately each of the plants mentioned, and ascertain what evidence can be extracted from them.

AUTE, or PAPER MULBERRY (*Broussonetia papyrifera*).—When Captain Cook * visited the Bay of Islands in 1769 he noticed in cultivation about half a dozen of the "cloth plants" with which he had become familiar while in Tahiti. The cloth made from the bark, he remarked, was very scarce, being worn only as an ornament in the ear, and rarely seen. Of the various articles offered to the natives in barter by the crew of the "Endeavour," the *tapa* cloth brought from Polynesia, everywhere, excepting Queen Charlotte Sound, was most highly esteemed. Possibly the southern natives, who were not agriculturists at Cook's time, had lost this memento of their former home. Their indifference may, however, point in a different direction.

The presence of the paper mulberry, or *aute* as it was generally styled throughout Polynesia as well as New Zealand, proved beyond doubt that the latter islands were regularly colonised—not accidentally peopled, the explanation until recently generally received. In Polynesia, where the shrub was extensively cultivated for the sake of its bark, it was invariably propagated by cuttings. A transportation of the plant thus raised across the broad expansive ocean that separates the nearest of the Polynesian groups from New Zealand bespeaks at once skill and forethought; the scarcity of the plant, and the fact of its dying out since the missionaries commenced their labours in New Zealand, shows that even after it was established in the country it could only be grown with the utmost care.

The *B. papyrifera* belongs to the flora of Japan, and probably to that of China, where it still furnishes material for one of the many fabrics called "grass cloth." How the species found its way into Polynesia, and from thence to New Zealand, there is little hope of discovering, but its presence in

* "Captain Cook's Journal."

the Pacific is unmistakable evidence of intercourse between agricultural nations, and of the wide dissemination of cultivated plants at a very remote period.

Throughout the warm regions of the Old World beaten or felted bark cloth was formerly in general use, as cotton stuffs are at present. Throughout the great chain of islands that extends from Sumatra to the Hawaiian Archipelago it was, during the last century, the principal article of clothing worn by the inhabitants.* Ellis found it in use amongst the natives of Madagascar; and, prior to Arab invasions, excepting the skins of animals, it was the only material with which the people of Central Africa covered themselves.† The best description of this African cloth, manufactured by the Uganda who occupied the northern shores of the Victoria Nyanza, closely resembles the *tapa* cloth of Polynesia. Grooved mallets, similar to those used in the Pacific islands, and which, like them, imparted to the fabric a corded appearance, were employed in its preparation.‡ It is worthy of remark that the Uganda who navigate the great lake use outrigger canoes,§ and that scattered throughout their country and the adjoining Unzoro State are many large dragon-trees, the genus *Dracæna* to which they belong being, according to some authorities,|| originally confined to the Malay and Polynesian regions.

The manufacture of felted bark cloth is evidently a more primitive art than weaving, for, wherever the loom is known, bark cloth is only found amongst the rudest sections of the population; this is the case in Madagascar, though the woven fabrics are of a very rude description. On the African Continent and in Polynesia, where bark cloth was the principle clothing material, spinning and weaving were unknown, though cotton and other fibrous plants are indigenous.

Taro, or *Colocasia arum esculentum*, has been cultivated in Hindostan for more than four thousand years. As the species readily escapes from cultivation, it is impossible to determine the exact habitat of the wild stock; we are therefore unable to decide whether the species belonged originally to the Malay Islands, and was there brought into cultivation, or whether it was introduced as a cultivated plant. Throughout the Pacific region, wherever the inhabitants were agriculturists, when Europeans first came in contact with them the *Colocasia* was one of the most important esculents; the correspondence of the Malay names *tallus*, *tallas*, *tales*, or *taloes* with the Polynesian *dalo*, *taro*, and *talo* leaves little room for doubt that it

* "Madagascar." Samuel Pasfield Oliver.
† "Artes Africanae." Dr. G. Schweinfurth.
‡ "Albert N'yanza." Sir S. Baker.
§ "Emin Pasha in Central Africa."
|| Personal narrative of travels. Humboldt and Bonpland.

found its way from the Asiatic islands into the Pacific region. This conclusion is strengthened by the fact that the New Zealand natives, though cut off from their Polynesian relatives, preserved the names of plants they introduced, and conferred on indigenous species names in vogue throughout the Eastern Pacific.

When Captain Cook took refuge in the Endeavour River, North Australia, he discovered, near to where Cooktown now stands, quantities of the *Colocasia* growing wild. As, according to the best authorities, the species does not belong to the Australian flora, we can only conclude that the continent had been visited at some former time by an agricultural people, though the art was unknown to the aborigines.

In Polynesia the taro was grown in swamps or on artificially irrigated land; in New Zealand it was planted in ordinary dry ground. Notwithstanding this adaptation of culture to the climatic conditions, it was only in the northern portion of the archipelago the *taro* could be successfully raised. The very few cultivated plants the New Zealand people possessed being so ill adapted to the climate of the country accounts for an agricultural people being mainly dependent on the root of a wild fern (*Pteris aquilina*) for their vegetable supplies. Though many species of the order *Aroideæ* are bitter and poisonous, rude hunting peoples, having discovered how to expel the deleterious properties, use the roots for food. From this, together with the very wide distribution of the cultivated *Colocasia* in the Old World, it is supposed to have been one of the first plants brought into cultivation.*

HUE, or CALABASH (*Lagenaria vulgaris*).—Throughout the tropical portion of the Old and New Worlds various species of the *Lagenaria* were extensively grown to furnish domestic utensils known under the general name of calabash. Whether the American calabash in cultivation before the time of Columbus was merely a variety of *L. vulgaris* is uncertain. From ancient records we learn that this species has been in cultivation on the Asiatic Continent for more than four thousand years. As the species does not belong to the Polynesian flora, we must conclude that it was introduced from the west, the white-flowered or Asiatic variety being everywhere in cultivation when Europeans entered the Pacific.

In Cook's time the New-Zealanders grew the *hue* as an esculent, and for the manufacture of drinking-vessels; in this we see the effects of the country being peopled directly from the tropics, for nowhere else so far within the temperate zone were these utensils in general use.

The earliest discoverers of Easter Island assert that the

* "Origin of Cultivated Plants." A. De Candolle.

natives possessed rude earthenware, but elsewhere in Polynesia eastward of Fiji pottery at that time was unknown; hence the questions naturally arise, Was the art lost, or was it ever introduced? Unlike the Australian aborigines, the inhabitants of New Zealand and Polynesia perfectly understood the use of boiling water in cookery; it seems, therefore, incredible that such a simple and useful art was allowed to perish where there was abundance of material, and that all the widely-scattered sections of the Pacific nations relapsed to the rude and tedious method of boiling by means of heated stones. These questions can only be satisfactorily settled by the careful examination of middens and the sites of ancient settlements. In the north temperate zone rude hunting peoples, unacquainted with the use of metals, manufactured very serviceable articles of clay;[1] it is therefore difficult to understand the backward state of the art in many of the Malay Islands within a very recent period, unless we can suppose that the various substitutes for pottery which the vegetable kingdom afforded, such as the bamboo, cocoanut shells, and calabashes, checked its development.

KUMARA, or SWEET POTATO (*Convolvulus batatas*).—From an historical point of view this is the most important plant cultivated by the inhabitants of New Zealand and Polynesia. When Columbus discovered the West Indian Islands he found a sweet potato there in cultivation, and transported it to Spain, from whence it spread to the Philippines, where it received the name "Castilian yam." The rapid dissemination of the *C. batatas* and other New-World species, such as the manioc, maize, and tobacco, amongst the agricultural nations of Africa, before either Arabs or Europeans penetrated into their countries, might lead to the supposition that the presence of the *kumara* in Polynesia only dated from the time of the American discovery. But we have the positive evidence furnished by Cook that, when he rediscovered New Zealand, and discovered the Hawaiian Archipelago in 1778, the *kumara* was the cultivated plant on which the inhabitants chiefly depended for food. As neither the New-Zealanders nor the Hawaiians had at that time any intercourse with the outer world, or any definite knowledge of places or people beyond their respective groups, it was impossible for them to have obtained the *kumara* in the same manner as the negro tribes.

From the close resemblance of the name *cumar*, by which the sweet potato was known in Quito when the Spaniards conquered that country, to the various Polynesian names, *kumara*, *umara*, *gumara*, &c., it has been suggested that the plant found its way into the Pacific directly from South

[1] "Antiquity of Man." Sir C. Lyell.

America, where it was extensively cultivated, it being in accordance with Polynesian custom to preserve foreign names, merely altering them to suit their mode of speech. But the question arises, Why did not the introduction of New-World cultivated plants go further, several species being as well adapted to the Polynesian region as the *kumara*, while others would have supplied the wants of the New Zealand agriculturists? To this question I shall again return.

The exact distribution of the *kumara* in the Pacific at the commencement of the sixteenth century cannot be determined, but we learn from Fletcher, to whom we are indebted for an account of Drake's celebrated voyage, that when the "Golden Hind" reached the Caroline Islands, in 1579, the inhabitants brought off to the vessel "cocoas, fish, potatoes, and certain fruits to small purpose."* Drake and his followers having been in the West Indies previous to this voyage of circumnavigation, must have been acquainted with the sweet potato (*C. batatas*); we may therefore safely conclude that the root referred to by Fletcher was the *kumara*, and that it had been transported without the direct or indirect intervention of Europeans to the north-western extremity of Polynesia, though it had not made its way across the intervening sea to the Philippines.† Moresby and Strachan‡ found the *kumara* in New Guinea amongst people that had never previously come in contact with Europeans, and to whom the use of metal was unknown. As Moresby also discovered maize in the D'Entrecasteaux Islands, possibly the *kumara* may have made its way into New Guinea through the Malay Archipelago.

From the *aute*, the *taro*, and the *hue* we gather that the inhabitants of the Pacific must formerly have been in communication with the Malay Islands or some other part of the Old World. From the *kumara*, on the other hand, we learn that during a long period preceding the advent of Europeans this intercourse was suspended, though at the same time the inhabitants may have had access to the New World: this evidence of isolation will be frequently confirmed in the course of this investigation.

HARAKEKE, OR NEW ZEALAND FLAX-PLANT (*Phormium tenax*).—When the missionaries commenced their labours in New Zealand the natives had in cultivation several varieties of the *P. tenax*, from the fibres of which their finest description of clothing was manufactured; fibres obtained from the wild harakeke and the leaves of the *ti* (*Cordyline australis*), every-

* "The World Encompassed," by Sir F. Drake. Fletcher.

† "Discoveries in New Guinea and Polynesia," by Captain J. Moresby.

‡ "Explorations and Adventures in New Guinea," by Captain J. Strachan.

where abundant, furnishing their ordinary dress. Though the New-Zealanders surpassed their Polynesian relatives in the manufacture of textile fabrics, all their garments were hand-plaited, the loom and spinning-wheel, or even the distaff, being unknown. Besides these hand-plaited garments, cloaks worn only by persons of rank were made from the skins of dogs, the only domestic animal they possessed. When to these dress-stuffs are added bark cloth, the principal clothing material throughout Polynesia, and cinctures of leaves,* frequently the only covering worn by females, it will be seen that, though no section of the Maori race went habitually naked, their clothes were of the most primitive descriptions. They were, however, far in advance of the Australian aborigines and the Papuans, with whom they were mixed, few of those people wearing any clothing whatsoever, even their ornaments being scarce and extremely rude.

II.—The Cultivated Plants of Polynesia: Foreign Species.

The great chain of islands that extends eastward from Sumatra along the equator as far as the Marquesas Group forms a zone of vegetation unparalleled in any other portion of the globe, the same climatic conditions prevailing throughout its whole length—more than eight thousand miles, or one-third of the earth's circumference. Excepting a few alpine forms, there is probably no species of plant found on any one portion of the line that would not grow on all other portions where it could find suitable soil wherein to fix its roots.

Here, then, those agencies by which plants are disseminated over the earth (man included) have had a wide, unbroken field of operation, and in the varied distribution of the species throughout the region their effects are now visible.

On examining this distribution we find that amongst the most widely distributed are the cultivated plants; but to this rule there are some marked exceptions, showing that the action of man as a distributing agency has been irregular or interrupted. Generally the stream of vegetation has been from west to east, though in a few instances the reverse is observable; but wherever cultivated plants of foreign origin are found history can be accurately determined—with one or two exceptions, they seem invariably to have entered at the western end of the chain. In the cultivated plants of the Polynesian islands, which form the eastern extremity of the great chain, we have a means of determining this easterly movement, or, in other words, the interchange of productions that has taken place between the inhabitants of the various

* "Polynesian Researches," by W. Ellis.

sections into which the archipelago is divisible. As in the case of the Maoris, the cultivated plants possessed by the Polynesian people in the pre-European time were partly of foreign origin, partly indigenous productions; of the former the most important were the breadfruit, banana, cocoanut, yam, apé, Malay apple, and winter cherry, besides those already mentioned as having found their way into New Zealand.

BREADFRUIT (*Artocarpus incisa*).—In popular works the breadfruit has been so intimately identified with Polynesian people that we are apt to regard it not only as an indigenous production, but as one confined to the islands. Its original habitat was, however, the Malay Archipelago, where it was brought into cultivation at so remote a period that the cultivated varieties, of which there are many, ceased to bear seed, and are propagated by suckers.* As eastward of the Fijis only the cultivated or seedless varieties are found, it was evidently introduced into and spread through Polynesia by man.†

Moresby informs us that the cocoanut and breadfruit are the only two large trees capable of growing on the small purely coral islands;‡ their importance in Polynesia, where so many of these small islands exist, is therefore evident.

For the dissemination of the breadfruit some skill in the art of agriculture was clearly necessary. Were, then, all other evidence wanting, the presence of these seedless varieties alone would be sufficient to prove the regular colonisation of the islands.

In the Marquesas, the most easterly of the Polynesian groups, the breadfruit was the principal food of the inhabitants, the best-known varieties being there grown. As these varieties, of which Ellis states the early missionaries were acquainted with fifty,§ ripening in different seasons of the year, must have been raised from seed, the question naturally arises, Where was the cultivation effected?—eastward of the Fijis no seeding specimens having been observed. To this question I will return in another chapter.

The breadfruit does not grow on the mainland of Asia. It must, therefore, have been brought into cultivation within the Malay Archipelago. Evidently, then, arboriculture was understood in that portion of the world at a very early period. On the mainland the breadfruit is represented by the jackfruit (*Artocarpus integrifolia*), which is a native of Southern Asia.

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* "Jottings in the Pacific." W. Wyatt Gill.

† "Origin of Cultivated Plants." A. De Candolle.

‡ "Discoveries in New Guinea and Polynesia." Captain Moresby.

§ "Polynesian Researches." W. Ellis (No. 1).

No mention being made of it in ancient Persian, Sanscrit, or Chinese writings, De Candolle concludes that it has been brought into cultivation in comparatively recent times, or not before the Christian era.* The species found its way into the Malay Islands in the pre-European time, but had not spread into Polynesia when Foster observed the cultivated plants of that region. We can here see that, while the Polynesian people possessed the ancient Malay plant, they had not received the more modern species; and as we proceed with this investigation we shall find that this is a rule holding good throughout.

BANANA (*Musa sapientum*, or *Musa paradisiaca*).—The original habitat of the banana, like most of those plants very long in cultivation, cannot be determined accurately, but the balance of evidence is in favour of the Malay Islands, where alone a wild species is found, from which the cultivated plant may have been derived. The banana, like the breadfruit, having become barren by long cultivation, can only be multiplied by offsets and suckers; its wide dissemination through Polynesia is therefore another proof of the colonisation of these islands.

On the mainland of Asia the banana has been cultivated for more than four thousand years.* Throughout the greater portion of tropical Africa, where Europeans only lately made their way, it has been found in cultivation, but it had not reached the portion of the Niger Valley explored by Park towards the end of the last century, though he observed it growing near the mouth of the Gambia, where it had been introduced by the Portuguese.†

Early Spanish writers assert that the Peruvians possessed two varieties of the banana before the European discovery of the New World, and Humboldt, from his own observations, confirmed these assertions; but it seems quite certain that the species was unknown in the West Indies or along the eastern portion of the mainland at the time of Columbus's discovery. Owing to these latter facts, the accuracy of the Spanish writers has been disputed by many able authorities, amongst them De Candolle, who, after summing up all the evidence procurable, concludes as follows: "If, however, later research should prove that the banana existed in some parts of America before the advent of the Europeans, I should be inclined to attribute it to a chance introduction not very ancient, the effect of some unknown communication with the islands of the Pacific, or with the coast of Guinea, rather than to believe in the primitive and simultaneous existence of the species in

* "Origin of Cultivated Plants." A. De Candolle.
† "Travels in Africa." Mungo Park.

both hemispheres. The whole of geographical botany renders the latter hypothesis improbable, I might almost say impossible, to admit, especially in a genus which is not divided between the two worlds."

I mentioned in the preceding chapter that the *kumara*, *Convolvulus batatas*, an American species, was cultivated throughout Polynesia before the European period, though it had not reached the Malay Archipelago. This necessarily implies an intercourse between some portions of the island region and the continent; hence that the Peruvians were in possession of the banana before the European discovery of America is extremely probable, for it would only show that an interchange of products had taken place between them and the Polynesians. It might be asked, Why did this exchange not go further? To this, at present, we can give no reply. Regarding the non-occurrence of the banana in the West Indies, or on the continent outside Peru, we know that, though the potato *(Solanum tuberosum)* had been long cultivated in the latter country, it was unknown in Mexico, or even in Brazil, at the time of the European invasion; thus it may be seen that, though an interchange of products did take place between the ancient civilized portions of the American Continent, the exchange was either very slow or intermittent.

To transplant the banana from Polynesia to the shores of America across more than two thousand miles of ocean would overtax the skill and knowledge of any ordinary European gardener; but for a people who have dispersed this species and the breadfruit through the countless islands that form their home it would be a simple undertaking. What we have really to consider here is: Were the rude inhabitants of Polynesia sufficiently acquainted with the arts of navigation and shipbuilding to be able to perform so perilous a voyage? This question will be considered in another place.

COCOANUT-PALM (*Cocos nucifera*).—The most ancient historical notices of the cocoanut are probably those discovered on the walls of the temple at Thebes, erected by Queen Hatasu to commemorate the return of the fleet sent out by her from Port Sais on a voyage of discovery down the Red Sea.* This fleet, we are informed, reached the distant land of Punt, from whence cocoanuts and other products of the country were brought back to Egypt. In the bas-reliefs which adorn Queen Hatasu's temple the residences of the inhabitants of Punt are depicted standing upon tall piles and embowered in cocoanut-palms. The products of the country not corresponding with those of the Asiatic coast, it has been conjectured that the land of Punt may have been the Somali

* "Ancient Egypt." Professor G. Rawlinson.

Coast, or some portion of Africa in the direction of Zanzibar, the inhabitants being represented of dwarfish stature; but it is questionable whether cocoanuts were growing in Africa at that distant period, or more than three thousand years ago. It was not until after Vasco da Gama had discovered the Cape of Good Hope that the cocoanut was introduced on the west coast of Africa by the Portuguese. Its introduction into Ceylon has been since the commencement of the Christian era, and until very lately the cultivation of the tree in India was restricted to the Brahmins, thus showing that there also it was a comparatively recent addition to the cultivated plants.

That the cocoanut-palm has long been cultivated in Madagascar is evident from the number of places to which it has given a name. Thus we have the Village *Ambouniko*, which means "at the cocoanut", the River *Ambodivouniko*, "at the foot of the cocoanut." In the Malagasy name of the cocoa-palm, *niko* is so similar to the Polynesian name *niu*, and to *nikau*, the native name of the only palm (*Areca sapida*) belonging to the New Zealand Archipelago, as to suggest that the cocoanut was introduced from the Pacific into the great African island. When Polynesian navigation comes under consideration we shall find this suggestion curiously strengthened.

In the Malay Archipelago and Polynesia the cocoanut is most abundantly cultivated, the varieties grown being almost innumerable. As we proceed eastward from the Malay Islands these varieties diminish in number until we reach the west coast of South America, where a single wild species occurs. Though the tree was unknown in the West Indies, or along the east coast of the continent, when Columbus made his discovery, it is quite certain it was growing wild on the western side of the narrow isthmus; hence the question has arisen, Where was the original habitat of the species—in the Old World or in the New? The botanical evidence is entirely in favour of the New World, all the other species of the genus *Cocos* being confined to America. The historical evidence, on the other hand, points to the Malay Islands. The species being littoral and the fruit well adapted for floating on water, it has been suggested that it may have found its way accidentally from Polynesia to the American coast within comparatively recent times. Pickering, who visited a great many of the small uninhabited Polynesian islands, states that he did not meet with a single instance of the spontaneous extension of the species.* These observations have been confirmed by Woodford in a recently-published work on the Solomon Islands, wherein he says, "From repeated observa-

* "Races of Man." Charles Pickering.

tion I am convinced that cocoanut-palms will rarely grow, and certainly will not bear fruit, unless attended to and kept clear of overgrowing trees."* Amongst the Cingalese there is a saying that the cocoanut-palm will not grow out of the sound of the sea, or of human voices. Moresby informs us that, although the cocoanut is extremely plentiful along the whole of the south coast of New Guinea, and on some of the islands in Torres Straits, it does not occur anywhere along the coast of north or east tropical Australia. This cannot be due to anything either in the soil or climate, for trees planted by Europeans at Cardwell were doing well when Moresby made his observation;† we must therefore conclude that the spontaneous extension of the cocoanut is not so common as is generally supposed, and that its wide dispersion throughout the whole of the equatorial islands is mainly artificial. This view is further strengthened by the fact that the extension of the species in these seas exactly coincides with the extension of the art of agriculture. Recognising this, De Candolle has suggested that the presence of the cocoa-palm on the American coast might be due to the accidental arrival of some Polynesian natives having some of the fruit with them; but, considering the wide expanse of ocean these people would have to cross, it seems to me that this "accidental" hypothesis only removes a difficulty by substituting an improbability.

Here, again, the presence of the *kumara* in Polynesia suggests an explanation. The cocoanut may have been transported in the same manner as the *kumara*, and as probably the banana also was. It is evident, however, if this was the case, this removal must have taken place at a period far more remote than that of the other species. When the ancient monuments of Polynesia come under consideration it will be seen that this is no difficulty.

I have already mentioned that the botanical evidence is altogether in favour of the American origin of the cocoanut-palm, a greater number of varieties occurring in the Malay Archipelago. In the case of the breadfruit, most of the varieties are found in eastern Polynesia, the original stock belonging to the western islands. We cannot, therefore, arrive at any positive conclusion from the distribution of varieties. If the cocoanut-palm was transported from Polynesia to America as a cultivated plant, it would probably be found in cultivation on that continent instead of in a wild state, the ancient inhabitants having made little use of the fruit. Throughout Poly-

* "A Naturalist amongst the Head-hunters, Solomon Islands." C. M. Woodford.

† "Discoveries in New Guinea and Polynesia." Captain Moresby.

nesia the cocoanut was of the utmost importance, as many of the islands would have been uninhabitable without it. If its presence on these islands was due to cultivation, we have in it another important evidence of the colonisation of the region.

Yam (*Dioscorea alata*).—The numerous species of the genus *Dioscorea* are scattered over the tropical portions of the Old and New Worlds. Many have large farinaceous rhizomes, which differ much in quality, some being good for human food, others having acrid or even poisonous properties. Yams, as these rhizomes are generally termed, have been used as food by the rude inhabitants of all tropical countries wherein they are found before they became acquainted with the art of agriculture.

Baron von Mueller informs us that the aborigines of Australia consume large quantities of the roots of *Dioscorea hastifolia*, and that "it is the only plant on which they bestow any cultivation, crude as it is."* Probably the yam was one of the first roots cultivated by man. In the New World several species were found in cultivation by the early European explorers; none of these exactly agreed with Old-World species, but some of those found on the western side of the continent were allied to Japanese forms.

The common yam (*Dioscorea alata*) was found in cultivation throughout Polynesia by the old European navigators. Another species, *Dioscorea sativa*, was also cultivated, but the rhizomes contained an acrid principle, and required a particular sort of cooking, hence it was less in vogue than *D. alata*, which seems to be foreign to the region, though its original habitat cannot be accurately determined, it being now very widely spread both on the mainland and the Asiatic islands. Since the European discovery of America the indigenous species cultivated there have been superseded by African and Asiatic species.

This process of selection, when the cultivated plants of different regions become intermingled, is seen in the case of *Triticum spelta*, which is now only found in a few places in South Germany and Switzerland, having been driven out of cultivation by wheat (*Triticum vulgare*). As the spelt has not been discovered wild, it will probably become extinct should it cease to be cultivated. We may thus see that plants brought into cultivation at a very early period may have been subsequently lost through the invasion of their territory by species better fitted to supply the wants of the inhabitants. How readily a rude agricultural people adopt new plants that can be advantageously grown by them is seen in Africa, where the manioc, maize, and sweet potato, all New-World species,

* "Select Extra-tropical Plants." Baron F. von Mueller.

are extensively cultivated in districts beyond European or even Arab influence. Thus the absence of certain plants capable of growing in a region may enable us to judge how long the inhabitants have been isolated from the portion of the world wherein these plants are found.

The eagerness of the Maoris to obtain new seeds and roots was sometimes taken advantage of by unprincipled persons. Darwin informs us that at the Bay of Islands dock-seed was sold to the natives for tobacco; thus the country became overrun with this troublesome weed as far back as 1835.* We may from this safely conclude that the very few foreign plants the Maoris had in cultivation was entirely owing to a want of opportunity to obtain more.

APÉ (*Alocasia macrorhiza*, or *Arum macrorhizum*).—As this species is found wild throughout the Polynesian and Malay Islands, it was probably brought into cultivation in some portion of the region. It is also found wild and cultivated in Ceylon and on the mainland of Asia, but the Malay names of the plant do not indicate its introduction from the continent.

The apé, though producing a larger root than the taro, is not so extensively cultivated, owing to a bitter principle, which has to be expelled before cooking. Here we have another instance of a cultivated species being supplanted by an allied species having better qualities.

The very early discovery of how to separate the noxious from the wholesome portions of vegetable substances accounts for so many poisonous plants being in the first instance brought into cultivation. Amongst the large number of European esculents, though many are unpalatable and indigestible before cooking, none can be considered actually poisonous, a fact doubtless due to a long process of selection carried on over extensive areas.

MALAY APPLE (*Eugenia malaccensis*).—This species belongs to the Malay Islands, where it was brought into cultivation evidently at a remote period, judging by the number of varieties found. It was cultivated throughout the Polynesian islands in pre-European times, but had not extended its range to the Asiatic Continent or other portions of the tropical world. Another species, the *Eugenia jambos*, belonging to, and widely cultivated on, the mainland of Asia, was not found in Polynesia by Forster. We can thus see that the Malay Islands formed at some remote period an independent centre of cultivation, whence the species brought into use were carried eastward to Polynesia, but did not always extend themselves in other directions till long afterwards.

The narrow latitudinal range of the breadfruit is probably

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* "Voyage of a Naturalist." Darwin.

due to its inability to grow far outside the equatorial zone. As this is not the case with the Malay apple or cocoanut, some other cause must have prevented a more rapid distribution at the remote period when they were brought into cultivation. Taken in connection with the fact of so few cultivated species finding their way from the mainland of Asia through the Malay Islands to Polynesia, I think we may infer a very restricted intercourse between the peoples of the two regions.

Poroiti (*Solanum oleraceum*).—This species belongs to the flora of the New World, and was brought into Europe during the last century. The bright-scarlet berries and leaves of the plant were formerly eaten by the Hervey Islanders, but I do not know whether the species was regularly cultivated or merely grew wild. I have introduced the *poroiti* in order to call attention to the many New-World species bearing edible fruit that had found their way into Polynesia previous to the advent of Europeans. Goodrich, one of the first foreigners who ascended Mauna-loa, discovered white and red raspberries, strawberries, and whortleberries growing plentifully at a high elevation, where alone, within the Hawaiian Archipelago, these plants would find a suitable climate. From the geographical position of Hawaii, we may safely conclude these fruit-bearing plants were American species; and, taking their number into account, it was improbable they were accidentally introduced, or by any other agents than man.

Pickering, who paid particular attention to the foreign plants scattered throughout Polynesia, found the Cape gooseberry (*Physalis peruviana*) growing wild in the Hawaiian and other groups, where it had more than one native name.† As nearly all the introduced plants observed by Pickering belong to the Asiatic region, the presence of the above-mentioned fruit-bearing species seems to confirm what we gather from the *kumara*—that the inhabitants of Polynesia had at some time communication with the American Continent.

III.—The Cultivated Plants of Polynesia: Indigenous Species.

The indigenous plants artificially multiplied by the Polynesian people were for the production of food and clothing, or for ornamental purposes. Of these the most important are the arrowroot, Tahitian chestnut, Tahitian apple, shaddock, ti-tree, and pandanus.

Pia, or Arrowroot (*Tacca pinnatifolia*).—This species grows abundantly in a wild state on many of the islands of eastern Polynesia, where it is also cultivated, but only on a

* "Polynesian Researches." W. Ellis.

† "Races of Man."

limited scale. The tubers yield an excellent starch, which, we learn from Ellis,* was always used on festive occasions, but did not enter into the ordinary food of the inhabitants. This, he considers, was due to the labour required in its preparation; but the difficulty of cooking, owing to the want of earthenware or other vessels capable of withstanding fire, may have been in part the cause. Starch obtained from the roots of a fern, *Pteris aquilina*, var. *esculentum*, was largely used as food by the New-Zealanders, who were probably acquainted with the art of preparing starch when they entered the New Zealand Archipelago.

The very few cultivated esculents these people possessed made the fern-root of great importance to them, and compelled the labour required in the preparation of the starch. Throughout the Malay Islands sago starch is extensively used; in some of the groups it forms the chief food of the inhabitants. It is obtained from various species of palms belonging to the genera *Metroxylon*, *Sagus*, and *Corypha*, none of which seem to be regularly cultivated, though in many places the trees have individual owners.† On the south-east extremity of New Guinea Dr. Gill informs us that the light-skinned Papuans make use of starch as food,‡ but he does not state from what species of plant it is obtained. Westward of the Fly River Strachan found the sago-palm growing in great abundance, but the inhabitants were unacquainted with the art of preparing the starch, and merely used the dried pith as food.§ On some of the islands of the Solomon Group, where the sago-palm is also very abundant, the natives in time of scarcity use large pieces of the pith of the tree baked as food, but do not prepare starch, while in other places they were well acquainted with the process;‖ but neither in this nor any other of the Polynesian groups was the art of drying the starch into cakes, as practised by the Malays, understood.

Starch, or farina, was largely used as food by the ancient civilised inhabitants of the American Continent, and is still the principal food of large sections of the Brazilian population.¶ This starch was principally obtained from the root of the *Manihot utilissima*, an indigenous plant having poisonous properties. The true arrowroots belonging to the genus

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* "Polynesian Researches." W. Ellis.
† "The Malay Archipelago." A. R. Wallace.
‡ "Life in the Southern Islands." W. Wyatt Gill.
§ "Explorations and Adventures in New Guinea." Captain J. Strachan.
‖ "A Naturalist among the Head-hunters." Charles Morris Woodford.
¶ "Travels in Brazil." George Gardner.

Maranta are all American, and were discovered there in cultivation by the early European navigators. The manioc is now largely cultivated throughout the whole of the tropical world. On the west coast of Africa, where it is called cassava, the starch, called tapioca, obtained from it is largely used by the natives. Livingstone,* in his journey to Loanda, noticing the prevalence of weak sight amongst the inhabitants, attributed it to a too general use of this food, but starch does not seem to have been anciently used by the peoples of Africa, for Speke,† Elton,‡ and Stanley§ make no mention of it, even in countries where the cassava is at present abundantly cultivated.

The importance of dried starch to a people who were not in possession of any of the cereals, as an article of food that might be stored, is obvious. Whether its general use by the ancient Americans and the Malayo-Polynesian peoples bespeaks a connection, or was merely indicative of a primitive condition of the agricultural art, we are not in a position to decide.

TAHITI CHESTNUT (*Inocarpus edulis*).—In the islands eastward of New Guinea this tree seems constantly to have been planted by the natives. The Rev. Dr. Gill‖ mentions that one was pointed out to him on the Island of Vaitupu, one of the Ellice Group, as having been planted by the first natives who arrived from Samoa; but whether it was an indigenous species or introduced by man he does not say, though probably, as Vaitupu is a mere coral island, the latter was the case. As far as I am aware, the chestnut did not find its way into the Malay Islands in ancient times; and this seems to be the case with regard to all the plants brought into cultivation in the eastern islands of the great chain. Probably the productions of the larger masses of land that constitute the Malay Islands were much superior or better fitted for the use of man. Another species belonging to the same order as the chestnut, the *Mimusops kauki*, produces a fruit which Dr. Gill says is very largely used as food by the natives of southern New Guinea; but this tree also seems to have remained confined to its original habitat. All the species of this order, regarded by De Candolle as cultivated plants, belong to the American Continent, and were brought into use by the ancient inhabitants of the regions in which they are found. As their culture has not much extended since they became known to Europeans, we can only conclude that the fruits they produce are

* "Travels in South Africa." Dr. D. Livingstone.
† "Journal of Discovery of the Source of the Nile." J. H. Speke.
‡ "Travels among African Lakes and Mountains." Elton and Cotterill.
§ "Through the Dark Continent." H. M. Stanley.
‖ "Life in the Southern Isles." Rev. Wyatt Gill.

not highly esteemed, and that their cultivation in the first place was owing to a restricted choice.

TAHITI APPLE (*Spondias dulcis*).—This tree has been carried by Europeans into various parts of the tropical world, but in ancient times it seems to have been confined to the islands eastward of New Guinea, where its fruit was largely used as food. Another species belonging to the same order, the mango (*Manifera indica*), a native of the Asiatic mainland, found its way into the western Malay Islands at a remote period, but had not extended its range to Polynesia in Forster's* time, and only reached the Philippine Group after those islands had been visited by the Portuguese. This confirms what we have already gathered from other sources—that the communication between the various sections of the great island belt was slow or irregular.

SHADDOCK (*Citrus decumana*).—The islands eastward of New Guinea, being the only region in which this species has been discovered positively wild, must be regarded as its original habitat, whence it spread westward. It had found its way into China before it became known to Europeans, but its now wide extension is due to the latter people. The sweet orange (*Citrus aurantium sinense*), undoubtedly of Chinese origin, existed in the Polynesian islands, but was not generally diffused in Forster's time. Moresby found it in New Guinea amongst people who, until he came in contact with them, had never seen Europeans.† From this we may conclude that the species was being disseminated throughout the island belt by the agency of the natives before Europeans had much intercourse with the region. Evidently the orange cannot be included amongst the ancient cultivated plants of Polynesia, described in the last chapter, for, had it been introduced along with them, it must have been as generally distributed as they were. As far as we can perceive, its dissemination depended on accident, while, as already shown, they were designedly conveyed from place to place.

TI-TREE (*Dracæna terminalis*).—Throughout the Polynesian islands this species was generally cultivated for its roots and leaves; the roots being used as food, and the leaves for the manufacture of clothing. *Ti* is the Maori name of the *Cordyline australis*, which is allied to, and resembles, the *Dracæna terminalis*. From the leaves of the *Cordyline* slippers and ropes were made by the Maoris, the roots being also used as food. We have a good example here of the manner in which names are introduced and applied by the natives.

* "Origin of Cultivated Plants." A. De Candolle.

† "Discoveries in New Guinea and Polynesia." Captain J. Moresby.

PANDANUS (*Pandanus utilis*).—Throughout the islands eastward of New Guinea this species, both cultivated and wild, was the most widely-disseminated plant made use of by man. In New Zealand the flowers and fruit of the *kiekie* (*Freycinetia bankscyi*), belonging to the same natural order, were also largely consumed by the natives, but I am not aware that the plant was ever multiplied by cultivation. The Rev. Dr. Gill, in his work "Life in the Southern Isles," thus describes one of the uninhabited islands visited by him: "Spending a pleasant day once on an uninhabited island—Nassau Island—I was surprised to see hundreds of robber-crabs asleep on the branches of lofty trees. In perfect safety they hung in rows, holding by their sharp-pointed toes in the shade of a primeval forest. These robber-crabs could not have existed on cocoanuts, as there was at that time but a single tree growing on the island. In all probability they had fed on the oily nut of the pandanus, which grows in great abundance near the sea. For the benefit of distressed voyagers, we planted upwards of thirty young cocoanut-trees, not without a misgiving that these fierce crabs might destroy them. Such however, was not the case, for they are now—1876—laden with fruit."

Before reading this I was inclined to regard the robber-crab as a proof of the Polynesian origin of the cocoanut-palm, the ease with which it tore open the monster fruit being, seemingly, an adaptation; but the presence of the animal where the cocoanut is not found does not favour this view. The thick fibrous covering and the strong shell of the cocoanut are clearly an adaptation to the rough waves by which the nut must be so largely disseminated, the tree being littoral, and frequently growing out over the water.

NOTE.—The adaptation of the cocoanut to the sea may appear out of keeping with what has been said regarding its distribution among the Pacific islands; but I do not consider the structure of the fruit has anything to do with long sea-voyages: its adaptation is to the rough waves of the shore, along which the fruit must be so frequently carried and thrown up. Woodford states, in his work on the Solomon Islands, that the young cocoanut-palm will not grow beneath the shade of other trees. As we know that it thrives and bears fruit in situations where its roots are frequently damped by salt-water, we can see that the seed thrown ashore by the waves would be placed in the most favourable situation for growth.

IV.—POLYNESIAN AGRICULTURE.

In the foregoing chapters we have seen that nine species of plants foreign to the region were found in cultivation amongst the Maoris of eastern Polynesia and New Zealand by early European voyagers—besides the cocoanut, the true habitat of

which has not been satisfactorily determined. Of these nine species, all but one—the *kumara*—belong to the Asiatic flora, and must have found their way into Polynesia from the west. In that direction, therefore, it seems reasonable to seek the origin of Polynesian agriculture. Of the eight Asiatic species, the breadfruit, banana, Malay apple, yam, alocasia, *taro*, *aute*, and calabash—on the first six of which the Polynesians were mainly dependent for food—belong, probably, to the Malay Islands. The breadfruit, as we have already seen, is unable to live on the mainland; the now widely-distributed banana and the Malay apple, as far as can be determined, originally belonged to the island region; while the *taro*, alocasia, and yam may have been brought into cultivation either there or on the continent, being found wild in both situations. The question, then, naturally arises, Is the Malay Archipelago the birthplace, or one of the birthplaces, of agriculture?—for it is quite possible the art may have had more than one starting-point.

The presence of the seedless breadfruits and bananas in eastern Polynesia, and of the *auté* or paper mulberry in New Zealand, proves beyond doubt that both regions were regularly colonised, and not accidentally peopled, as many writers have asserted. We know that into New Zealand all the cultivated plants the Polynesian people possessed capable of withstanding the climate were introduced. It seems therefore reasonable to conclude that in like manner all the plants in cultivation amongst the people of the Malay Archipelago at the period of Polynesian colonisation were also transplanted there, the climatic conditions of the two regions being the same.

In Polynesian agriculture, at a period immediately preceding the European intrusion, we have, then, evidence of what Malay agriculture was at a more remote epoch. Considered as a whole, the Malayan plants found in cultivation amongst the people of the Pacific form a collection of esculents well adapted to support a people dwelling within or near the equatorial belt, where vegetable growth is constant throughout the year, and where, owing to the absence of periodicity, it is unnecessary to store provisions during any great length of time; but, besides their incapacity to withstand a low temperature, the perishable nature of their products unfits these species for countries where, from the lack of moisture or a low temperature, vegetation is periodically suspended.

Leaving Polynesian agriculture, if we direct our attention to other portions of the earth we will find that both in ancient and modern times the labour of the husbandman has been chiefly directed to the production of commodities capable

of being stored for indefinite periods. In Egypt, China, and those parts of southern Asia whence we obtain the most ancient records of agriculture, the cereals, wheat, rice, millet, &c., have formed the principal crops for more than five thousand years. In Arabia and parts of northern Africa, where the climate prohibits the growth of corn, the date-palm furnishes the principal food of the inhabitants, the fruit being well fitted for storing. In the New World the farinaceous seeds of the quinoa (*Chenopodium quinoa*), and the maize, or Indian corn (*Zea mays*), originally formed the chief food of the Peruvians and Mexicans.

Agriculture may thus be divided into two classes—the agriculture of the monotonous climates and the agriculture of the variable climes. From the facts that in the northern portions of the Old World, where the art is of comparatively recent introduction, it commenced at once with the growth of corn, and that even in the Malay Islands, though the ancient plants above referred to are still grown, they are of secondary importance compared with rice, it might at once be inferred that in the ancient Malay agriculture we have the more primitive form of the art.

Before finally accepting this conclusion, which would at once locate the birthplace of agriculture within or near the equatorial belt, it would be well to look a little more into the history of the art and its probable origin. Going back sufficiently far in the history of mankind, we arrive at a period when all existing races subsisted on the wild or spontaneous productions of the earth, supplying themselves with animal food by hunting and fishing, and vegetable food by collecting wild fruits and roots. In every quarter of the globe evidences of this period have been obtained, either from ancient burial-grounds or other human remains, our knowledge being further extended by a study of still-existing savage races. From these various sources we learn that in ancient as in modern times the dwellers in high latitudes subsisted chiefly on animal food, while those living nearer to the equator were largely dependent on vegetable products. Thus the Esquimaux, Samoyedes,† and other inhabitants of the Arctic regions have frequently no other vegetable diet than the lichen obtained from the stomach of the reindeer slain in the chase, and a species of fungus is the only vegetable the natives of Tierra del Fuego add to their scanty diet of fish.‡ On the other hand, the Digger Indians of California, one of the lowest of the aboriginal races, derive their name from the quantities

* "Origin of Civilization." Sir J. Lubbock.
† "Voyage of the 'Vega'." Nordenskiold.
‡ "Voyage of a Naturalist." Darwin.

of wild roots and fruits they consume; and in Africa the Damaras*, Bosjesmans, and other rude tribes that do not cultivate the soil subsist largely on pig-nuts and other wild vegetable products. Thus, owing to the natural conditions of existence amongst the primitive races, some lived chiefly on animal, others on vegetable, food. In their progress towards civilization the former probably passed directly from the hunter to the pastoral state, the latter to the agricultural state.

In the long barrows or burial-places of a small Iberian people who anciently occupied the western coast of Europe and the British Islands, and whose descendants are still seen in the Spanish Basque and amongst the people of the western counties of Ireland, along with human remains and with rude stone implements the bones of various wild animals are found interred, the only domestic species being the dog. In the round barrows containing the remains of the large Keltic people, by whom the Iberians were supplanted, bones of cattle and goats, as well as dogs, have been discovered, but from neither the Iberian nor Keltic tombs have any traces of agriculture been obtained, acorns, hazel-nuts, and other wild fruits being the only vegetable products disinterred.†

The pastoral nomads of Central Asia, who until very recently used stone implements and subsisted almost exclusively on the produce of their flocks and herds, cultivating no species of plant, furnish a living example of the ancient Keltic societies.‡ From the tombs of the ancient Peruvians many cultivated plants have been obtained, but these people could never have passed through the pastoral state, the llama, alpaca, dog, and guinea-pig being the only domesticated quadrupeds the Peruvians possessed at the period of the Spanish intrusion.§ New Guinea, Borneo, and other portions of the tropical world furnish abundant examples of peoples who have adopted the practice of agriculture while still retaining many of their savage customs.||

The rudest attempt at agriculture of which we have any knowledge is that made by the aborigines of northern Australia, and to which reference has already been made, the only plant cultivated by this people being the native yam (*Dioscorea hastifolia*); all they can have received from without is the idea to increase by planting the root they already used for food.

In its very early stages it is probable that this is how the practice of agriculture extended itself. Before the process of

* "Narrative of an Explorer in South Africa." F. Galton.
† "Origin of the Aryans." Isaac Taylor.
‡ "Russian Central Asia." Rev. H. Lansdell.
§ "Conquest of Peru." Prescott.
|| "Pioneering in New Guinea." James Chalmers.

selection commenced, between the products of the wild or self-sown and artificially-sown plants there would be no difference, and consequently nothing could be gained by transporting the artificial fruits or roots where the wild might be obtained, though from imitating the practice of planting a benefit would certainly be experienced. This would probably account for the large number of the *Dioscorea* that have passed into cultivation in various parts of the world.

Where the first agricultural community arose it is impossible to determine, but we may possibly discover where the conditions necessary to such a result occurred. These conditions were obviously a settled population, a regular climate favourable to vegetable growth, a fertile soil, and fruits, roots, or other indigenous esculents already in use.

From the kitchenmiddens* or shell-heaps found along the shores of the Baltic, and from similar remains in other parts of the world, we learn that primitive races, who subsisted by fishing, often occupied the same locality for a great length of time. On the shores and islands of tropical seas, and in the estuaries of great rivers flowing into these seas, the physical conditions above enumerated occur in many places. Here, then, fishing communities, having once received the idea of increasing their supply of vegetable food by planting, might well develope into agricultural communities, or even into agricultural states. The Japanese, who have undoubtedly been an agricultural people from a very ancient time, asserting that they are the descendants of fishermen, still maintain the practice of including a piece of seaweed or dried fish with any gift they may have to bestow, regarding this as a token of their origin,† fish being also the only animal food used by a great mass of the people. Throughout the Malay Archipelago, also, fish and vegetables fully supply the requirements of the inhabitants, who thus seem to be constitutionally independent of other descriptions of animal food.

Pickering,‡ speculating on the origin of agriculture, made the table-lands of Thibet, Mexico, and Peru the birthplaces of the art. The open, garden-like nature of the vegetation, and the mild, uniform, moist climates of these elevated tracts, together with the many indigenous edible roots, would, he considered, have suggested the idea of increasing the food-supply by planting. On the other hand, he contended that in a dense forest country the clearing of the land would demand an amount of labour rude savages are incapable of; but we know that amongst rude agricultural people who have

* "Man before Metals." Professor N. Joly.
† "Unbeaten Tracks in Japan." Mrs. Bishop (Isabella Bird).
‡ "Races of Man." C. Pickering.

a choice of situations the forest land is invariably preferred. In North America, where there are wide areas of open land, the agricultural operations of the semi-hunting tribes, unacquainted with the use of metal, have been thus described: "The Indians belt (*coupent*) the trees about 2ft. or 3ft. from the ground; then they trim off all the branches and burn them at the foot of the tree, in order to kill it, and afterwards take away the roots. This being done, the women carefully clean up the ground between the trees, and at every step they dig a round hole, in which they sow nine or ten grains of maize, which they have first carefully selected and soaked for some days in water."*

The Dyho† cultivations general throughout the mountainous parts of Hindostan are dependent on the forest land; and in Polynesia the land at first rescued from the forest is, after being in cultivation a few years, allowed to grow up in trees, when it is again cleared and brought under crop.‡

To any one who has resided some time in newly-settled country and devoted his attention to agriculture the reason for this seeming waste of labour is obvious. Naturally open grass or fern land is generally unproductive until after it has been broken up and exposed to the sun and air for some time. Forest land, on the contrary, is most fertile immediately after the timber has been burned off, and is also for a time free from weeds. Forest fires and the dense luxuriant growth of shrubs that appear after the destruction of the large timber may have suggested this primitive mode of husbandry. As many of these shrubs—for instance, the raspberries that come up on clearings in North America, the *poroporo* (*Solanum aviculare*) and the Cape gooseberry (*Physalis peruviana*) that follow the destruction of the New Zealand bush—produce edible fruit, even the idea of agriculture may have been thus originated.

The most important effect of agriculture as regards modern civilization has been the enormous increase of population it gave rise to. It has been estimated that, of pastoral nomads like the Kirghiz of Central Asia, France would support about fifty thousand, and the whole pastoral zone of northern Europe not more than a million, or about half the population of the Lower Nile Valley at the time Memphis was founded and the pyramids built.

In the earliest historical period the great mass of the Old-World population was contained within a narrow zone, extending from China on the east along the southern portion of

* "The Mounds of the Mississippi." Lucien Carr.
† "Highlands of Central India." Capt. J. Forsyth.
‡ "Jottings in the Pacific." Rev. W. Wyatt Gill.

Asia to Egypt on the west, where it terminated abruptly. As within this zone we know that at first the population was most dense along the seaward margin, history seems at once to confirm the conclusion arrived at from physical data—that it was the dwellers by the ocean agriculture first bade increase and multiply.

In Egypt the most ancient evidence of agriculture has been obtained, but there is nothing in this evidence to lead to the conclusion that the Nile Valley was the birthplace of the art; on the contrary, it seems to have been introduced there in a somewhat advanced state. Wheat, which formed the staple food of the people from the very earliest time, was not an indigenous species, nor has Egypt produced any one of the most important esculents known to be in cultivation more than four thousand years, unless it might be millet (*Panicum miliaceum*), the origin of which is doubtful; indeed, the lower portion of the Nile Valley is not a region to which we would naturally look for the origin of cultivated esculents, except rice, which we know was not introduced into the country until after Alexander's return from his Indian conquests. Presenting the appearance of a lake during about three months of the year, with a rainless climate, the indigenous species were necessarily peculiar in their habits. In the upper portion of the Nile Valley, between the Sobat junction and Gondokoro, we can still, probably, see what Egypt was before man laid hands upon it. Here a wilderness of tall reed-grasses and sedge, interlaced with convolvulus and other climbing plants, borders the river on either side, the land from which this dense, tangled mass of vegetation arises being periodically a morass or a parched desert.* Although its land, its climate, and its flora preclude the possibility of Egypt being the birthplace of agriculture, it was pre-eminently adapted, as results have proved, to be the home of an agricultural people. During more than six thousand years the Lower Nile Valley has supported a population not only sufficient to cultivate its soil, but to create that vast assemblage of monuments to which we are so largely indebted for our knowledge of the past. In following back the traces of civilization one important fact we gather from Egyptian agriculture is, however remote its commencement may have been, there was a more ancient agriculture to which it owed its being.

Let us now turn to the eastern extremity of the ancient zone of population—to China and the adjacent portions of the Asiatic Continent, extending from the tropics northward towards cold latitudes. Here we at once discover all the conditions necessary to the birth as well as the development of

* "The Albert Nyanza." Sir S. W. Baker.

agriculture. In the southern portion, where the monotonous and regular tropical climate prevails, it is only necessary to commit the seed roughly to the soil, regardless of season, to insure a return. In other parts the time of sowing has to be studied, and care bestowed on the ground. From this region, if we include in it the islands of the adjacent seas, a large proportion of the Old-World species, cultivated more than four thousand years, has been derived. From Chinese records we gather that five of the cereals, including wheat and rice, were cultivated in that country 4,700 years ago, rice being undoubtedly an indigenous species there brought into cultivation.

Excepting European agriculture of the present century, it is in this region—in China and Japan—the art has attained its highest perfection. Within it also we find the rudest attempts at cultivation of which we have any knowledge. We can even go further back than this, for in the sago-eaters of the Isle of Ceram* we have a people living almost exclusively on vegetable food without cultivating the plants on which they depend, for the various species of *Rumphius* from which the sago is prepared are not sown, though the plants have individual owners. Here, then, it seems reasonable to conclude agriculture first took the form of a regular art, and that from hence it spread westward to the shores of the Mediterranean, and eastward among the islands of the Pacific. As already stated, Egypt has been an agricultural state for more than six thousand years. It may now be asked, When did the art enter Polynesia? The presence of the seedless breadfruits and bananas, besides proving that the countless islands of eastern Polynesia wherein they occur were regularly colonised, show that agriculture must have been well advanced in the Malay Archipelago when this colonisation took place, the growing of plants from suckers and cuttings, and how to transport them across broad expanses of ocean, being evidently understood. Although Polynesian agriculture is certainly less ancient than Malayan, we must accord to it a considerable antiquity if we accept as evidence the absence of certain cultivated esculents.

From historical sources we learn that Java was colonised during the first century of the Christian era by the Javanas, who, by some authorities, are supposed to be descended from the Greek invaders of India.† With this colonisation the cereals, *Leguminosæ*, and other cultivated plants commonly diffused in the more civilised portion of the Old World would be introduced into the Malay Islands if they were not previously there. As none of the species referred to were

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* "The Malay Archipelago." A. R. Wallace.
† "Orissa." W. W. Hunter.

observed in Polynesia by early European voyagers, we can only conclude that the colonisation of that region took place at an earlier date, and that communication between the eastern and western portions of the great island zone was interrupted from that time forward to the period of European enterprise. If this conclusion is correct, it enables us at once to understand the presence of the *kumara* in Polynesia and its absence from the Malayan Archipelago. It may have been introduced into the former region during the period of isolation, but the probability of this would be better appreciated when the ancient civilization of the eastern Polynesian people comes under consideration.

While the foreign cultivated esculents found in Polynesia indicate a former connection with the islands of the Indian Ocean, or with the American Continent, the only foreign plant cultivated as a material for clothing is of Japanese or Chinese origin. Are we then to conclude that between these countries and Polynesia an intercourse also formerly existed?

I have already mentioned, while referring to the cultivation of this Japanese species, the paper mulberry (*Broussonetia papyrifera*) in New Zealand, and the inferences to be drawn from it—that precisely the same mode of manufacturing bark cloth was until recently in vogue amongst the peoples of Polynesia, of Central Africa, and of Madagascar, though the barks used in the various places were derived from different species of trees. The only possible way of accounting for the wide distribution of this curious art is that it spread from some central situation, where it was discovered or perfected, and that it was adapted to the natural productions of the countries into which it made its way. A similar diffusion of the arts of spinning and weaving, and their adaptation to various descriptions of animal and vegetable fibres in different parts of the world, we know has taken place within historic times, though the arts date back to prehistoric ages.

From Ellis, the apostle of Madagascar, to whom we are indebted for a description of the Polynesian *tapa* cloth and the process of manufacture, we learn that when he visited the great African island the manufacture and use of this bark cloth was restricted to isolated localities that had little communication with the outer world. In other portions of the island the arts of spinning and weaving were understood, but the machines in use were of the very rudest description. As neither in Polynesia nor Central Africa the distaff, spinning-wheel, or loom were known, while the bark cloth was in general use, I think we may safely conclude that it is more ancient than the woven fabrics, and that it has been superseded by them; but we know that in Egypt, Babylonia, India, and China the woven fabrics have been in use more

than four thousand years. Where, then, was the centre of this ancient civilization of which the felted bark cloth is a trace, and which made itself felt from the Sandwich Islands to the shores of the Victoria Nyanza, it is not possible at present to determine; but from the presence of the paper mulberry, and its very careful cultivation in Polynesia, it seems extremely probable that the ancient Polynesian people were in direct, or almost direct, communication with that centre.

Excepting the breadfruit, which is not found wild or cultivated on any of the continents, it is not possible to determine positively where the Malayan esculents anciently introduced into Polynesia were first brought into cultivation; but from the fact of the banana, taro, alocasia, and yam being all grown on the mainland of Asia for more than four thousand years, I think it is safe to conclude that even before that very early period there was an interchange of products between the archipelago and the continent, and that the Malay Islands constituted an important portion of the then civilized world. Through the Malay Islands the paper mulberry and the art of manufacturing its bark into cloth may have reached Polynesia, although the great social and political changes the western islands have undergone have there obliterated all traces of that portion of their history. The two stations wherein Ellis observed the manufacture of the *tapa* cloth—eastern Polynesia and Madagascar—prove beyond doubt that the art was diffused by a maritime people. From the association of the art with Polynesian agriculture it is extremely probable that, while in a very primitive condition, agriculture was similarly and as widely dispersed.

V.—The Domestic Animals of Polynesia.

When Cook discovered the Hawaiian Archipelago, in 1778, and Mendana discovered the Solomon Islands, in 1568, they found the natives in possession of dogs, pigs, and fowls. As it seems certain no European vessel had touched at the Hawaiian Islands previous to Cook's visit, and there is still less reason to suppose that the Solomons were visited by Europeans before the date of Mendana's discovery, we may safely conclude that the three above-mentioned animals were in domestication throughout Polynesia prior to the European discovery of the New World. To these foreign species another domestic animal, not so generally distributed, must, I think, be added, the *Megapodius brenchleyi*, of which Woodford, in his work on the Solomon Islands, gives the following description: "The birds lay in open, sandy clearings, generally near the sea, which are kept clear of shrubs and undergrowth by the natives, and by the sand being constantly turned over by the birds. The eggs are buried sometimes as

deeply as 2ft. from the surface, and are hatched by the natural heat of the hot sand. Many thousands of birds congregate at the same place, the laying-yards being often some acres in extent. At the Island of Savo, where these birds especially abound, they become so tame that I have seen a native digging out eggs and birds digging fresh holes to lay in within a few yards of one another."*

The presence of this bird in some of the islands of eastern Polynesia can only be due to human agency. In Niafu, one of the very remote islands of the Tonga Group, the Megapodes are very numerous. Romilly, who visited the place in 1881, states that the coast is so rocky and precipitous the natives are unable to keep either boats or canoes; and he thus describes the mode of landing: "Landing can only be managed on the calmest days, and even on shore there is no spot where a boat can be beached. There is a slippery rock on which the natives stand, and, as you watch your opportunity for a jump, they form a chain, holding each other's hands. You then make your spring, and the last native of the chain catches you any way he can, and hauls you up like a bale of goods."† Yet these people possess horses, and have constructed a bridle-road round the large lake of mineralised water that occupies the centre of the island. Niafu is subject to very violent earthquakes, during one of which, some years back, a large portion of the land, with all its inhabitants, disappeared suddenly beneath the ocean. On this submerged land, it is supposed, there was a place where horses could be landed. It may thus be seen how the presence of an animal in a certain locality may confirm a very imperfectly-recorded fact, or even reveal a fact, in the absence of any record. The Niafu horses testify to the activity of our own times, the Megapodes to the activity of some former period.

The *Megapodius brenchleyi* is found as far west as Celebes, and was observed at the Philippines by Pigafetta, who accompanied Magellan, the eggs being there used and sold like those of ordinary domestic fowls.‡ As this family of birds belongs to the Australian region, there can be little doubt that its presence in Celebes and the Philippines is also due to human agency. By what people this dispersal was effected will be considered in another chapter.

From what has been ascertained regarding the general distribution of animal life, we are able to say with certainty that the dingo, or wild dog, of Australia is foreign to the fauna of that continent, and must, therefore, have been introduced

* "A Naturalist among the Head-hunters." C. M. Woodford.
† "The Western Pacific and New Guinea." H. H. Romilly.
‡ "The Life of Ferdinand Magellan." F. H. H. Guillemard.

intentionally or accidentally by man. The natives tame the dingo, and train it to hunt, but it cannot be considered a domestic animal, as these same specimens often refuse to follow their owners; and the females, when in young, always disappear before the period of parturition, the natives being thus dependent on the discovery of litters of pups in the bush.* That they fully recognise the value of the dingo as an assistant in the chase is shown by the care they take of the few they possess. According to Lumholtz, they are more attentive to their dogs than to their children. From this I think it may be safely concluded the dingo was not introduced as a domestic animal either by or with the present aborigines, for had they ever possessed it in domestication they would not have allowed it to go entirely wild.

The natives of Tierra del Fuego, who are far lower in the scale of humanity than the Australians, maintain a breed of domestic dogs they value so highly that in times of famine they eat their old women rather than sacrifice these animals.† As the natives of New Guinea, as well as those of Polynesia, had dogs in domestication before Europeans came in contact with them, the question arises, Why do the aborigines of Australia differ in this respect from them, and from most savages of whom we have any knowledge? Woodford, who travelled in Australia, and was familiar with the dingo, ascertained during his visits to the Solomon Group that it is identical with the ancient domestic dog of those islands. And from the following description left by Crozet of the now extinct New Zealand dog it is evidently identical with that animal also, and consequently, we must infer, with the ancient dog of Polynesia: "The only quadrupeds I saw in this country were dogs and rats. The dogs are a sort of domesticated fox, quite black or white, very low on the legs, straight ears, thick tail, long body, full jaws, but more pointed than that of the fox, and uttering the same cry; they do not bark like our dogs. These animals are only fed on fish, and it appears that the savages only raise them for food. Some were taken on board our vessels, but it was impossible to domesticate them like our dogs; they were always treacherous, and bit us frequently."‡ This, taken in conjunction with the fact before mentioned of the taro being found wild in a few parts of northern Australia, renders it extremely probable that some of the Polynesian people visited the continent and settled there for some time, and that the now feral animal and the feral plant were introduced by them. The ancestors of the various domestic dogs scattered over the

* "Among Cannibals." Carl Lumholtz.

† "Voyage of a Naturalist." Darwin.

‡ "Crozet's Voyage to Tasmania and New Zealand." Trans., H. Ling Roth.

world have not been ascertained; but, whether they have had a monogenetic or polygenetic origin, we must go outside both Australia and the great island belt to find the wild stock whence the dingo has been derived, for there is no animal proper to either of those regions to which its descent might be traced.

Throughout Polynesia, in New Guinea, and New Zealand the domestic dog, or domestic dingo, as it might be termed, is everywhere associated with the art of agriculture; we may therefore conclude that its dispersal was effected by a people acquainted with that art, and it is very probable that the art and the domestic animal appeared simultaneously in the region. From the remains of dogs discovered in the burying-places of the rude hunting tribes that formerly inhabited the northern portions of Europe and Asia, it is evident that the animal was brought into domestication before any portion of mankind had attained to the pastoral state.* How the domestication of the dog may have come about can be seen in the taming and training of the dingo by the Australian natives. As there is nothing in the arts or customs of the natives that might lead us to suppose they were more civilised than when Europeans first observed them, or that they are the offshoot of a more civilized nation, possibly they may have entered the continent prior to the domestication of the dog, or before it made its way into the part of the world from whence they have been derived.

Whether the Orang Poonans of Borneo keep dogs and employ them in the chase has not been positively ascertained; if they do not, as the information we possess goes to show, it strengthens the supposition that the great island region was peopled before the dog got into general use amongst the hunter nations of the world. Throughout Polynesia the dog, as an assistant in the chase, was of little use to the inhabitants except to capture pigs, after those animals became wild. In its very general dispersal we can see at what a very early period the fashion of keeping dogs regardless of utility commenced. In a few of the islands of eastern Polynesia, however, this adaptive animal was turned to a singular account, being fattened for food.

The ancient pig of Polynesia, which may still be found on a few of the islands, has been identified by competent observers with the wild pig of New Guinea (*Sus papuensis*), but whether this is really an indigenous species, or only, like the dingo, a feral animal, our knowledge of the great Australasian islands is too imperfect to justify a conclusion; but, considering the fauna of New Guinea as a whole, and the

* "Man before Metals." Professor N. Joly.

absence of the pig on the neighbouring continent, it is more than probable it was introduced by man. Of the various domestic animals, the Polynesian fowls furnish the best evidence of a former intercourse between the region and the Malay Archipelago, for we must proceed eastward of Celebes, or, perhaps, to the Peninsula of India, to discover the original habitat of the species, or where it was domesticated. The jungle-fowl being the only representative of the *Phasianidæ* in Celebes,* there can be little doubt that it is also a feral species.

As in the case of the cultivated plants, from the absence as well as the presence of certain domestic animals in Polynesia, important conclusions may be arrived at. In the preceding chapter we have seen that in the warm portions of the earth there is reason to believe man passed directly from the hunting or fishing to the agricultural stage, and in colder regions from the hunting to the pastoral stage. In seeking the birthplace of agriculture we must take into consideration both the Old World and the New, but regarding the origin of the pastoral industry only the former can furnish any evidence. Though the American Continent possessed many ruminants that if domesticated might have been of great service to man, only three herbivorous quadrupeds were found in domestication by the early European discoverers—the guinea-pig, alpaca, and the llama. Though the two latter were kept by the Peruvians in vast herds for the sake of their wool and flesh, the llama being also employed as a beast of burden, the use of milk, on which the true nomadic herdsman is so largely dependent, seems to have been entirely unknown to the aborigines of Peru.† Throughout a greater portion of the Old World milk forms an important item in the food of the inhabitants, certain rude tribes, such as the Kirghiz and Calmuck of Central Asia, and the Damara and Hottentot of Southern Africa, being almost dependent on it.

Like America, Africa possesses a number of indigenous ruminants, yet all the domestic species found amongst its inhabitants are foreign to the continent. It is impossible to determine exactly where the various species of domestic cattle, sheep, goats, reindeer, camels, and horses now scattered amongst the various nations of the world were first brought into subjection, but we can say with confidence that the wild stocks from which all were derived belonged to the Euro-Asiatic region. Here, then, the use of milk, and its various preparations as food, first came into vogue. As the milk and flesh of all the animals enumerated is or has

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* "The Malay Archipelago." A. R. Wallace.
† "Conquest of Peru." Prescott.

been at some former period used for food, it is probable that their domestication in the first place was effected with a view to the food-supply, though some are now employed almost exclusively as beasts of burden. There is abundant archæological evidence that several of these animals were in domestication amongst the rude inhabitants of Europe and the temperate portions of Asia before either the use of metal or the art of agriculture was known within those regions.* The Japanese furnish an example of an agricultural people keeping cattle but making no use of their milk. Miss Bird tells us: "We left Ichinono early on a fine morning with three pack-cows, one of which I rode, and their calves, very comely kine, with small noses, short horns, straight spines, and deep bodies. I thought that I might get some fresh milk, but the idea of anything but a calf milking a cow was so new to the people that there was a universal laugh, and Ito told me that they thought it 'most disgusting,' and that the Japanese think it 'most disgusting' in foreigners to put anything 'with such a strong smell and taste' into their tea." On this subject Humboldt made the following important remarks: "The cows yield milk plentifully enough in the lower regions of the torrid zone, wherever good pasturage is found. I call attention to this fact because local circumstances have spread through the Indian Archipelago the prejudice of considering hot climates as repugnant to the secretion of milk. We may conceive the indifference of the inhabitants of the New World for a milk diet, the country having been originally destitute of animals capable of furnishing it; but how can we avoid being astonished at this indifference in the immense Chinese population, living in great part beyond the tropics, and in the same latitude with the nomad and pastoral tribes of Central Asia? If the Chinese have ever been a pastoral people, how have they lost the tastes and habits so intimately connected with that state which precedes agricultural institutions? These questions are interesting with respect both to the history of the nations of oriental Asia and to the ancient communications that are supposed to have existed between that part of the world and the north of Mexico."

Throughout the greater portion of the civilized and partly-civilized world the rearing of cattle and other ruminants for the sake of their flesh and milk goes hand-in-hand with the

* "Antiquity of Man": Sir C. Lyell. "Origin of the Aryans": Isaac Taylor. "Origin of Civilisation": Sir J. Lubbock. "Unbeaten Tracks in Japan": Mrs. Bishop (Isabella Bird). "Personal Narrative of Travels": Humboldt, Bonpland. "The Long White Mountain (Travels in Manchuria)": James.

cultivation of the soil. A little milk is too often the only addition the ryots of India and the labouring people of Ireland have to their miserable diet of rice and potatoes. When and how the pastoral and agricultural industries became united would, if accurately determined, form one of the most instructive chapters in the history of civilization.

From the very commencement of their history the Egyptians seem to have carried on these combined industries, cattle being their only domesticated animals during a long period.* As these cattle and their cultivated plants belonged originally to the Euro-Asiatic region, we must conclude that the first intermingling of pastoral and agricultural tribes took place in some other portion of the world, and prior to the colonisation of the Nile Valley.

In equatorial and southern Africa we still find tribes depending exclusively on the cultivation of the soil, and others on the produce of their flocks and herds, but generally these two are found united within the same tribe; but in all cases the herdsmen form a distinct class, and affect a superiority over the agriculturists, or hoemen,† as they style them. From the knowledge we possess, it is evident that the pastoral industry was introduced subsequent to agriculture, and by a conquering people.‡ There can be little doubt that it entered the continent from the north-east. But whence was the art of agriculture derived? The presence of the manioc, maize, and sweet potatoes in parts of the continent where Europeans have only very lately penetrated renders the solution of this question extremely difficult, for they show how rapidly useful plants are disseminated amongst the negro races. Still, the very general cultivation of the banana and the colocasia, taken in connection with the bark cloth referred to in former chapters, favours the supposition that the art may have been introduced from some of the countries bordering on the Indian Ocean.

From what has come down to us of Asiatic history we may confidently conclude that the domestic ruminants made their first appearance in the south-eastern portion of the continent more than four thousand years ago, a period to which history also enables us to trace back many of our cultivated plants. Whether the domestic animals made their way at the same time into any portion of the great island region cannot be positively determined, but their complete absence from Polynesia, coupled with what we know of the Japanese, makes it extremely improbable, for, were they in the Malay Islands

* "Ancient Egypt." Canon Rawlinson.
† "Darker Africa." H. M. Stanley.
‡ "Emin Pasha in Central Africa."

when the easterly migration took place, they could scarcely fail to have been transported to some of the Polynesian groups; and this conclusion is strengthened by the fact that the people of the Philippines possessed domestic goats when Magellan discovered the group, though these animals, so easy to transport, were not found further eastward.*

To the progress of the inland pastoral peoples, who constantly swept down on southern Asia, the sea naturally presented an insurmountable obstacle. The Javanas, who overran the Malay Archipelago from India at the commencement of the Christian era, were the descendants of the Greek conquerors of Hindostan, and consequently a people better adapted for maritime enterprise than the Indo-Aryans, with whom they had become intermingled.†

Unlike the Old World, in the New the domestication of animals, if we except the dog, as well as the cultivation of vegetables, commenced within the tropics. This cannot be attributed to the physical features or fauna of the region, for in temperate North America all the conditions necessary to beget and develope the pastoral industry—wide-stretching grassy plains and ruminants well adapted for domestication—occur.

As the necessity for an artificial regulation of the food-supply is obviously greater in high latitudes, where long, severe winters have to be encountered, than near the equator, where a warm, monotonous climate prevails, the question naturally presents itself, Why, of all the aboriginal races, did those dwelling within the tropics alone try to make themselves independent of the wild or spontaneous productions of the country?

According to an ancient Mexican tradition, the civilization of that country was introduced by a bearded foreigner from the West. We have already seen that between eastern Polynesia and the New World a communication formerly existed. Although these two items of evidence corroborate each other in a remarkable manner, it would be rash to found a theory on them. Still, they show unmistakably the possibility of the ancient American civilization having been derived from Asia by way of Polynesia, or, in other words, the possibility of civilization, taken as a whole, being monogenetic, instead of polygenetic, as hitherto supposed. Here the great importance of Polynesian or Maori history becomes at once obvious; but this subject will be better considered in the sequel.

The only domestic animals the New-Zealanders possessed

* "Life of Ferdinand Magellan." F. H. H. Guillemard.
† "Orissa." W. Hunter.

when Cook first visited the archipelago were dogs. From this, and pigs being generally called *puaka* throughout eastern Polynesia, it is commonly supposed that their presence was due to European agency; but there is unmistakable evidence that the Polynesians possessed both pigs and fowls before the European period. Woodford, who was well aware of this, writes: "Captain Cook introduced the pig to New Zealand, but they were pigs that he had bought from the natives at Tahiti, and not that he had brought with him from England, as most people suppose. That the Maoris had no pigs I can account for on two suppositions: First, that at the time they migrated to New Zealand from Hawaiki the pig may not then have been introduced among the Polynesian natives of the Pacific; but chiefly, I think, on account of the long canoe voyage the Maoris must have had, wherever Hawaiki may have been. Bound all four legs together in the bottom of a wet canoe, as they assuredly would have been, no pig could survive very long, a pig being a most tender animal under such conditions. Besides, if they started with any, they would have been doubtless eaten before they got to the end of such a long voyage":* but before we can finally accept the latter conclusion it must be reconciled with the presence of pigs and fowls in the equally-isolated Hawaiian Group.

VI.—ANCIENT MONUMENTS AND MARINERS OF POLYNESIA.

Scattered over the countless islands of Polynesia are many stone structures concerning which the inhabitants were unable to furnish any intelligible information when Europeans first invaded the territories. Though these structures vary greatly in form and dimensions, all are of the Cyclopean type, constructed without any cementing material, the stones in some cases being jointed or dovetailed together, a style of building anciently in vogue in the opposite hemisphere as far north as the distant Hebrides.

On both the Carolines and Easter Island, the north-western and south-eastern extremities of the great island chain, these ancient monuments are especially numerous, but throughout middle Polynesia there is no group and few islands of any extent wherein they are not found.

When Cook explored Tahiti in 1769 he visited the great *marae* of Oamo, of which he has left the following description: "It is a long square of stonework built pyramidically; its base is 267ft. by 87ft.; at the top it is 250ft. by 8ft. It is built in the same manner as we do steps leading up to a sun-dial or fountain erected in the middle of a square, where there

*"A Naturalist among the Head-hunters" (Solomon Islands). C. M. Woodford.

is a flight of steps on each side. In this building there are eleven of such steps; each step is about 4ft. in height, and the breadth 4ft. 7in., but they decreased both in height and breadth from the bottom to the top. On the middle of the top stood the image of a bird carved in wood; near it lay the broken one of a fish carved in stone. There was no hollow or cavity in the inside, the whole being filled up with stones. The outside was faced partly with hewn stones and partly with others, and these were placed in such a manner as to look very agreeable to the eye. Some of the hewn stones were 4ft. 7in. by 2ft. 4in., and 15in. thick, and had been squared and polished with some sort of an edge tool. On the east side was enclosed with a stone wall a piece of ground, in form of a square, 360ft. by 354ft.; in this were growing several cypress-trees and plantains. Round about this *marae* were several smaller ones all going to decay, and on the beach between them and the sea lay scattered up and down a great quantity of human bones. Not far from the great *marae* were two or three pretty large altars, where lay the skull-bones of some hogs and dogs."

In the absence of historical records, it is only from the monuments themselves and their surroundings we can now hope to recover their history.

Easter Island, on which so many of these mysterious remains are found, is one of the most isolated spots of land on the surface of our globe, being about eighteen hundred miles distant from the coast of South America and fifteen hundred from the Gambier Group, the nearest land. The island, only thirty miles in circumference, was described by Cook as barren, almost treeless, and very badly supplied with fresh water, the formation volcanic, some of the peaks being over 1,000ft elevation.† The monuments, which have long been a subject of speculation, consist of stone houses, massively built, and placed in rows or streets; platforms from 200ft. to 300ft. in length, and 15ft. to 20ft. high on the outer or seaward side, constructed of hewn stones dovetailed together; stone statues 3ft. to 30ft. high, representing the upper portion of a human figure, sometimes standing on the platform and sometimes on the ground; and sculptured rocks, the subject being generally a human face. On the heads of the larger figures crowns made from a red volcanic stone were fitted. This material was formerly regarded as foreign to the little island, but further exploration proved it was obtained from a quarry at the south-west end of the island, another quarry at the opposite end having furnished the grey lava out

* "Captain Cook's Journal."
† "Captain Cook's Third Voyage."

of which the bodies of the figures and the pedestals on which they rested had been fashioned. In these quarries several finished and unfinished crowns and figures were discovered. One of these figures measured 20ft. from the nape of the neck to the top of the head, which was flattened for the reception of a crown. From the appearance of the eye-sockets, it has been conjectured that black obsidian eyeballs were originally inserted. Another peculiarity of the figures is the disproportionate size of the ears.

Regarding the erection of these statues, the Rev. W. Wyatt Gill gives the following particulars, obtained from the present inhabitants of the island: "Long, long ago there lived in Rapa-nui a famous artisan named Tukoio; he was also a magician. His sole delight was to carve in stone. His tools were merely sharp stone adzes, like those now in existence, only larger and stronger. When any of these statues were completed Tukoio would order them to travel to the sites where they now are. They at once obeyed; but on their way some of them, having had the misfortune to stumble and fall, were never able to rise again. The office assigned to these gods was to guard the island against the intrusion of strangers and the violence of the ocean. To this day they are known collectively as 'the Stones of Tukoio' (*Moai-na-Tukoio*). Each statue has also a separate name. Tukoio was deified after his death on account of his wondrous skill and might."*

It is evident that the works above enumerated could not have been executed without metal tools, or without some description of implement the island was unable to furnish.† To whom, then, must these remains be ascribed? In their persons, their language, their arts, and the cultivated plants they possessed, the modern inhabitants of Easter Island resembled exactly other nations of eastern Polynesia and New Zealand. One of their customs, the artificial extension of the ears until they touched their shoulders, seems to identify them with the builders of the monuments, who must have been, however, by far their superiors in art. Besides this curious custom, Roggewein and other early explorers observed amongst them grotesque but well-executed wooden images, having obsidian eyeballs and disproportionately large ears.

A disposition has recently been evinced by persons interested in the history of Polynesia to separate the ancient monuments into two groups, assigning those of Easter Island to a New-World people, while giving those of Micronesia and the adjacent groups an Asiatic origin. But in the remains

* "Jottings in the Pacific." W. Wyatt Gill.
† "Tropical Nature." A. R. Wallace.

discovered in the far-distant and recently-explored Neckar Island they have a link connecting the great Tahitian pyramid described by Cook with the colossal statues of south-eastern Polynesia. Amongst the Neckar Island relics was a *morie* fish, found lying on a stone altar, and grotesque human figures with immense ears, also carved out of stone.*

For the construction of the Easter Island monuments a large number of workers labouring during a comparatively short time, or a smaller number of workers and a longer time, is necessary; as the little badly-watered island is inadequate for the maintenance of a large population, it is more probable the remains testified to time than to a great number of inhabitants. To whichever view we may incline, it seems certain that the workmen who quarried and fashioned stone for the various structures must have been supplied from without with implements, or with material for their manufacture, and that this supply could only have been maintained by a people well acquainted with the arts of shipbuilding and navigation. In seeking these people, and from whence they derived their supplies, we naturally turn to the nearest possible and probable source. In Peru and Mexico ancient monuments of the Polynesian type are found, and both countries abound in metals of every description. From hence, then, it seems probable the architects of Easter Island may have been derived, and may have received what they required; but the Peruvians and Mexicans were not seafaring people, nor was there such a people anywhere in the New World† previous to its invasion by Europeans. The Peruvian *bulsu*, the highest type of vessel found on the shores of the American Continent, though well adapted for the transportation of merchandise from place to place along the coast at certain seasons, would have been a sorry craft wherein to undertake voyages of discovery, or for the colonising of a region like the Pacific.

If Easter Island during the period of its prosperity was in communication with any civilized nation of the New World, the inhabitants of that time must have completely disappeared before the ancestors of the present natives took possession, otherwise there would have been, in the productions of the little island, some evidence of their existence when Europeans discovered it.

Westward of the Carolines are the numerous groups constituting what is called the Malay Archipelago or East Indian Islands. In all of these groups the metals abound, and their present inhabitants are skilful mariners, who were capable of making long voyages before they came in contact with Euro-

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* "Polynesian Journal," vol. iii.
† "Conquest of Mexico"; "Conquest of Peru." Prescott.

peans or had European appliances at their command.* Here, then, we might reasonably expect to discover some clue to the mystery of the Polynesian monuments. But, before proceeding further, it will be well to examine the Polynesian people themselves.

Pigafetta, who accompanied Magellan, and was consequently one of the first Europeans who became acquainted with the inhabitants of the Pacific, has left an account of the outrigger canoes used by the natives of the Ladrones, and then seen for the first time by the Spanish explorers.† These strange craft, having the stem and stern alike, he tells us, were so dexterously handled by their occupants that they could pass between the Spanish ship and a boat towing astern.

Dampier, who visited the Ladrones in 1675, has given the following description of these canoes, or "flying proas" as they were termed: "The natives are very ingenious beyond any people in making boats, or 'proas' as they are called in the East Indies, and therein they take great delight. These are built sharp at both ends. The bottom is of one piece, made like the bottom of a little canoe, very neatly dug, and left of a good substance. This bottom part is instead of a keel; it is about 26ft. or 28ft. long. The under part of this keel is made round, but inclining to a wedge, and smooth; and the upper part is almost flat, having a very gentle hollow, and is about 1ft. broad. From hence both sides of the boat are carried up to about 5ft. high with narrow planks not above 4in. or 5in. broad; and each end of the boat turns up round very prettily. But, what is very singular, one side of the boat is made perpendicular, like a wall, while the other side is rounding, made as other vessels are, with a pretty full belly. Just in the middle it is about 4ft. or 5ft. broad aloft, or more, according to the length of the boat. The mast stands exactly in the middle, with a long yard that peaks up and down like a mizzen-yard. One end of it reaches down to the end or head of the boat, where it is placed in a notch that is made there purposely to receive it and keep it fast; the other end hangs over the stern. To this yard the sail is fastened. At the foot of the sail there is another small yard, to keep the sail out square, and to roll up the sail on when it blows hard; for it serves instead of a reef to take up the sail to what degree they please, according to the strength of the wind. Along the belly side of the boat, parallel with it, at 6ft. or 7ft. distance, lies another small boat or canoe, being a log of very light wood, almost as long as the great boat, but not so wide, being

* "Malay Archipelago." A. R. Wallace.
† "Life of Ferdinand Magellan." F. H. Guillemard.

not above 1½ft. wide at the upper part, and very sharp, like a wedge, at each end. And there are two bamboos of about 8ft. or 10ft. long and as big as one's leg placed over the great boat's side, one near each end of it, and reaching about 6ft. or 7ft. from the side of the boat, by the help of which the little boat is made firm and contiguous to the other. . . . I have been the more particular in describing these boats because I believe they sail the best of any boats in the world. I did here, for my own satisfaction, try the swiftness of one of them sailing by our log. We had twelve knots on our reel, and she ran it all out before the half-minute glass was half out, which, if it had been no more, is after the rate of twelve miles an hour; but I do believe she would have run twenty-four miles an hour."*

Lord Anson, sixty-three years later, after ascertaining accurately the sailing-capacity of the proa, thus sums up: "And by the flatness of their lee-side and their small breadth they are capable of lying much nearer the wind than any other vessel hitherto known, and thereby have an advantage which no vessels that go large can ever pretend to. The advantage I mean is that of running with a velocity nearly as great as, and perhaps sometimes greater than, that with which the wind blows."†

While Cook was sailing amongst the Tonga Islands the natives frequently quitted his ship, taking to their canoes in order to reach their destination in time to prepare for his reception.‡ There is, indeed, abundant evidence that before the advent of Europeans the natives of Polynesia thoroughly understood the arts of sailing and of constructing vessels well adapted for the navigation of their seas.

From most reliable sources we learn that during the last century voyages between the Fijis, Samoa, Tonga, and other islands, 310 to 400 miles apart, were frequently made by the natives in their canoes. Evidence of much longer voyages in the remote past has already been furnished by the cultivated plants of New Zealand and Polynesia.

How did these ancient mariners navigate their vessels? This difficulty caused early writers on Polynesia to attribute the peopling of the region to accident, some arguing that, owing to the prevailing winds being from east to west, the inhabitants must have been derived from the New World, others, recognising their Asiatic affinity, endeavouring to prove that their dispersal took place during the westerly storms that

* "A New Voyage round the World." William Dampier.

† "Crozet's Voyage to Tasmania and New Zealand." Trans., H. Ling Roth.

‡ "Captain Cook's Second Voyage."

occasionally sweep across the tropical zone of the Pacific.* But the following instructions for a voyage from Hawaii to Tahiti, handed down by a native historian of the Sandwich Group, shows how the ancient mariner found his way when not in sight of land: "If you sail for Kahiki you will discover new constellations and strange stars over the deep ocean. When you arrive at the *piko-o-wakea* (equator) you will lose sight of *Hoku-paa* (the North Star), and then *Newe* will be the southern guiding-star, and the constellation of *Humu* will stand as a guide above you."†

From these instructions we gather that the ancient astronomers of Polynesia had discovered the two hemispheres into which our globe is naturally divisible. They had a name for the equator, and consequently some idea of latitude. Thus they surpass the Greeks at the time of Herodotus, for that observant writer, whom there is no reason to suppose was behind the learning of his time when commenting on the circumnavigation of Africa, remarks: "Libya shows itself to be surrounded by water, except so much of it as borders upon Asia. Neco, King of Egypt, was the first whom we know of that proved this. He, when he had ceased digging the canal leading from the Nile to the Arabian Gulf, sent certain Phœnicians in ships with orders to sail back through the Pillars of Hercules into the northern sea, and so to return to Egypt. The Phœnicians accordingly, setting out from the Red Sea, navigated the southern sea. When autumn came they went ashore and sowed the land, by whatever part of Libya they happened to be sailing, and waited for harvest. Then, having reaped the corn, they put to sea again. When two years had thus passed, in the third, having doubled the Pillars of Hercules, they arrived in Egypt, and related what to me does not seem credible, but may to others—that as they sailed round Libya they had the sun on their right hand. Thus was Libya first known."‡

Evidently it is unnecessary to go outside Polynesia in order to discover people who were capable of maintaining an intercourse between the widely-scattered islands, or of going beyond the region to procure what it was incapable of producing.

VII.—CONCLUSIONS.

In the population of the Pacific region defined in the first chapter of this inquiry two very distinct ingredients are

* "Origin and Migrations of the Polynesian Nation." John Dunmore Lang.

† "Notes on the Geographical Knowledge of the Polynesians." By S. Percy Smith, "Transactions of the Australasian Association for the Advancement of Science," 1890.

‡ "Herodotus." Henry Cary.

recognisable — a dark-skinned negroid people and a light-complexioned people of the Malay type. Although these ingredients when Europeans came upon the scenes were more or less intermingled on the Australian Continent and in Tasmania, the negroid race was practically pure. In eastern Polynesia and New Zealand the light-complexioned inhabitants showed little of the negroid admixture, but in the remaining portion of the region, New Guinea, Melanesia, and Micronesia, the intermingling had produced an endless variety of colours and a babel of tongues.

Of the two races, the darker was undoubtedly the aboriginal, for, had New Guinea and the adjacent islands been peopled by the light-complexioned and more civilized people previous to the incoming of the dark-skinned inhabitants, it would have been impossible for them to effect the settlement. Though the people of eastern Polynesia were far in advance of the Australian natives, compared with any of the civilized nations bordering on the Pacific region at the commencement of the sixteenth century they were in a very backward state. Like their ruder neighbours, they were ignorant of the use of metals and of the potter's art, even in the simplest form; though they habitually clothed and subsisted by agriculture, their clothing materials and husbandry were of the most primitive types. In one important set of arts they excelled—as seamen and navigators they surpassed all other people of whom we have any information, excepting modern Europeans and those who ever acquired the knowledge. Were these light-complexioned people the architects of the ancient monuments, or was there yet another race in the Pacific region?

The distribution of the mysterious structures coincides exactly with the distribution of the most civilized section of the present population. In Micronesia, where both the dark- and light-complexioned people were represented, the darker people, holding an inferior position, cultivated the soil; the others, who were strictly prohibited from intermarrying with them, followed the sea—were the boatbuilders and fishermen.

The nearest counterparts of the Polynesian structures were discovered in Mexico and Peru, or in the portion of the world that represented the Age of Bronze. Turning to southern Asia, the most ancient home of civilization, it is only amongst the remains of the very remote past we find anything akin to these New-World and Polynesian monuments.

The ruined tombs and temples of Java, constructed during the first centuries of the Christian era, show how far architecture had advanced in the Asiatic islands in that remote period. The following description of the great temple of Boroboro, in

the Province of Redu, illustrates this advance: "This temple is built upon a small hill, and consists of a central dome and seven ranges of terraced walls covering the slope of the hill, and forming sloping galleries, each below the other, and communicating by steps and gateways. The central dome is 50ft. in diameter; around it is a triple circle of seventy-two towers; and the whole building is 620ft. square, and about 100ft. high. In the terraced walls are niches, containing cross-legged figures larger than life, to the number of about four hundred, and both sides of all the terraced walls are covered with bas-reliefs crowded with figures and carved in hard stone, and which must therefore occupy an extent of nearly three miles in length. The amount of human labour and skill expended on the Great Pyramid of Egypt sinks into insignificance when compared with that required to complete this sculptured hill-temple in the interior of Java."*

When in the Old World the builder's art had only reached the stage of development indicated by the Polynesian monuments, the use of iron was undiscovered, and stone implements had not been discarded. Bronze nowhere entirely superseded stone; in Peru and Mexico stone and bronze weapons and implements were employed at the time of the Spanish invasion. In the Peninsula of Sinai, where during many centuries the ancient Egyptians mined for copper and other minerals, quantities of arrow-heads and other stone implements have been recovered from the ruins of buildings connected with the mines. Inscriptions on these buildings show that, when these stone articles were in use, bronze ornaments and utensils were common in the cities of the Nile Valley.†

We can now readily perceive how a people dependent on foreign countries for a supply of metal might be forced to relapse from the use of bronze and stone implements into the exclusive use of stone, and how arts incapable of being carried on without metal tools would perish, while other arts survived.

What we particularly gather from the cultivated plants and domesticated animals of Polynesia is that in the history of the Pacific there was a period during which the region was in communication with the Malay Islands, and probably with the Asiatic mainland, and that this period was followed by a long interval of isolation, terminated only by the advent of Europeans.

From traces discovered outside the Pacific of the primitive Polynesian arts, there is reason to suspect that the more civilised inhabitants of the region, when they crossed the great ocean and colonised its countless islands, were on a par

* "Malay Archipelago." Wallace.
† "Sinai." Major Palmer.

with the most civilized nations of southern Asia. We have already noticed the wide distribution of the *tapa* or felted bark-cloth; the outrigger canoe, so characteristic of the Pacific, is found as far west as the Comoro Group,* between Africa and Madagascar, where the cocoanut has been long cultivated, and bears the name it is known by in Polynesia.

Just as we discover amongst the Malay peoples traces of art ruder than those at present in vogue, in eastern Polynesia there is unmistakable evidence of a higher social state. Between the widely-scattered islands a regular intercourse must formerly have been maintained, for in no other way is it possible to account for the extraordinary uniformity of language, arts, customs, and institutions, a uniformity which made Cook, after visiting so many of the groups, and discovering the Hawaiian Archipelago, designate all a nation.

For the maintenance of this intercourse, bespeaking such an amount of labour and great maritime skill, there must have been a sufficient cause—commerce, a central government, a powerful national religion, or, perhaps, all three combined.

Between the Polynesian islands, so very similar in climate and productions, there was little to beget trade. Though everywhere curious laws were strictly enforced, and a powerful priesthood existed considering the region as a whole, there was no head-quarters of either Church or State. The only explanation, then, that appears reasonable is that the palmy days of Polynesian history were while the inhabitants had access to the outer world, the subsequent decay being due to isolation. The cause of this isolation or when it commenced cannot be ascertained, but we know from historic sources that Java was colonised from Hindostan during the first century of the Christian era, and that henceforth the Malay Archipelago shared the vicissitudes of the Asiatic mainland—Buddhism, the first-established religion, giving place to Brahminism, which, in its turn, was in most places supplanted by the Mahommedan faith. With these creeds the arts and productions of the continent found their way into the islands. Previous to this the colonisation of eastern Polynesia must have been effected, though possibly the complete isolation of the region did not commence until long after.

When Magellan discovered the Philippine Islands and entered the port of Zebu, in 1521, he found there a Siamese trader. Notwithstanding this proof of the inhabitants being in communication with the great civilized world, they were so far behind the Javanese in art, and had so much in common

* "The Races of Man." Charles Pickering.

with the people in eastern Polynesia, it is probable that at a not very remote date they were included in the curiously-scattered island nation. The Philippine Islands being rich in metals and very varied in their production, between them and eastern Polynesia commerce would naturally arise. For a time the group may have been the centre of the ancient civilization, though at some former period that civilization must have been more widely extended.

Considering the great length of time the more civilized section of the population has been in the Pacific, it is extremely improbable that the region was previously inhabited by another great maritime people of whom there is no record, and who passed away leaving no trace of their existence save the mysterious monuments.

Their cultivated plants, their domestic animals, and their institutions all testified that the people whom Europeans discovered in eastern Polynesia had from the time of their incoming never been disturbed by an alien race, and that, excepting Micronesia, they must have found the islands uninhabited when they took possession. If the numerous stone structures scattered over the islands appeared foreign to the genius of the inhabitants, it does not warrant the conclusion that they could not have been the builders, for are there not in the histories of progressive nations abundant examples of the works on which a people expended their talent and energy being regarded by their descendants as evidences of folly and ignorance, and is it not reasonable to conclude that decay would also have an effect? When Roggewein cruelly discharged his muskets amongst the unfortunate inhabitants of Easter Island they ran for protection to the great statues, which they attributed to a man possessing supernatural power. This is precisely how we might suppose a people who had from the force of circumstances degenerated would regard the monuments of a more favoured age.

The presence of the *Convolvulus batatas* as a cultivated plant in Polynesia and in the New World can only be explained by some intercourse intentional or accidental, for there is no well-authenticated example of a species being brought into cultivation in more than one country. We have already seen that none of the New-World peoples were capable of crossing the Pacific; it remains now to inquire, Is there any evidence besides the kumara that the inhabitants of Polynesia made their way to the continent?

When America became known to Europeans the civilized nations were confined to a comparatively small area within the tropics, the remainder of the great continent, north and south, being tenanted by rude hunting tribes, unacquainted

with the use of metals, or by a people who practised agriculture, but were entirely ignorant of metals, or only used them as ornaments.

When the Spaniards overran their countries the Mexicans and Peruvians subsisted almost exclusively by agriculture, having few animals in domestication. They were skilful workers in gold and silver; unacquainted with iron, they manufactured implements of bronze, similar in its composition to the compound metal used in the Old World previous to the discovery of iron. Scattered over respective countries were populous towns and cities adorned with stately buildings, and connected by well-formed roads over which mails were regularly carried. They had ascertained with wonderful accuracy the length of the solar year, and had divided time accordingly. In many of their laws and institutions they compared favourably with the most advanced European and Asiatic peoples.

Long before any nation of the Euro-Asiatic or African Continents had progressed thus far in the march of civilization, the inhabitants generally had so far emerged from the savage state, only a very small proportion, residing in rigorous climates, were entirely dependent on the products of the chase. In the colder regions of the north the hunter had developed into the pastoral nomad; in the warmer zones agriculture was everywhere understood, plants adapted to the various countries having been brought into cultivation.

The absence of the pastoral industry and the complete ignorance of the use of milk for food amongst the inhabitants of the New World cannot be attributed to physical conditions, for it has been well proved that no parts of the world are better adapted for the raising of flocks and herds than the vast prairies of the North and the pampas and savannahs of South America. Nor were animals suitable for domestication wanting. Over the great prairies the bison roamed in countless numbers; on the mountain heights sheep and goats ran wild; and in the frozen region of the North the reindeer existed. The domestication of the alpaca by the Peruvians within the tropics showed that it was not to the want of opportunity the wide difference between the New-World and the Old-World peoples was due. Besides the absence of the pastoral industry, there were nowhere on the American Continent those evidences of the origin and development of art found in Asia and Europe. No cromlechs or dolmens showing architecture in its embryo state, no traces of how the civilized nations of Central America had been evolved. Isolated like a tree grown from a chance-dropped seed, these civilized communities existed, surrounded by peoples alien to them in spirit if not by blood. Amongst the ruder nations civilized arts were

spreading when Europeans came upon the scenes; already agriculture had made its way into the forest country of Brazil,* amongst the West Indian Islands, and across the continent as far northward as the Great Lakes.† In its northern extension it was only supplementary to hunting; nor had it been adapted to the exigencies of the climate, the plants of the warmer zone being alone in cultivation.

These differences between the New World and the Old World seem capable of only one explanation: The civilization of Central America was the result of colonisation by peoples farther advanced than the aboriginal race.

Returning to the Pacific, we have seen that the widely-scattered islands of eastern Polynesia and the New Zealand Archipelago had all been regularly colonised. It is impossible to believe that a people who made their way eastward from Malaya until they reached the Hawaiian Group in the north, and Easter Island in the south, would halt until they found the boundary of the great ocean, or that, having set foot on the continent, they would fail to do as they had elsewhere done, establish a settlement. If the civilization of America thus commenced, it might be supposed that in the arts and institutions of Peru and Mexico there would have been more traces of its origin. When we consider how extremely adaptive the colonising people were, the number of indigenous plants they had brought into cultivation throughout Polynesia and New Zealand; how, in the Southern Archipelago, they had adapted their mode of cultivating the taro, and had modified their clothing to suit the climate; and that, availing themselves of the large timber the islands furnished, they had abandoned the outrigger canoe, thus fulfilling an ancient Tahitian prophecy; when we take all this into account we readily perceive that amidst the productions of the great continent, and surrounded by an alien race, their arts, customs, and institutions would in time be so altered as to be unrecognisable.

Of the six most important esculents cultivated in Polynesia, the breadfruit could not have been grown on the western American seaboard. The cocoanut was wild on the islands off Panama. Yams and calabashes were generally cultivated by all the agricultural nations within whose domain they would grow. The banana was probably growing in Peru, though its limited extension is difficult to account for. There remains, then, only the taro which might have been advantageously introduced.

Considering how the indigenous cultivated plants of the New World have, since their dispersal, affected the agriculture

* "Personal Narrative of Travels." Humboldt.
† "The Mounds of the Mississippi Valley." Lucien Carr.

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of the Old World, it is reasonable to conclude that through a process of selection they may have in their own territories driven introduced species out of cultivation. What has particularly to be explained is why more of these plants did not find their way into Polynesia. If we are correct regarding the introduction of agriculture, they may not have been in cultivation when the kumara was transported. The wild progenitor of the kumara has not been discovered; its original habitat is consequently doubtful, but all the evidence forthcoming is decidedly in favour of Central America. By a people accustomed to the cultivation of roots, the plant, if discovered, would be readily taken advantage of. Until some means of dispelling the poisonous properties became known, the manioc would not have been brought into cultivation. To a people unacquainted with grain the maize would not soon commend itself, and it must have been after agriculture had reached the high, cool table-lands that the potato (*Solanum tuberosum*) came into use. We can thus see that of the four most important New-World esculents the kumara would naturally first attract agriculturists of the primitive Polynesian type.

Mention has already been made that the monuments of Polynesia resemble monuments found in Peru. In both cases these remains belong to a period long anterior to the European discovery. As the likeness might have been accidental, it cannot be considered positive evidence of intercourse between the two regions unless corroborative proofs can be added. These proofs are found in another branch of art. Between the distant Malay Islands and Peru an interchange of inventions must have at some time taken place. The heavy stonewood gravitana used by the natives of the Upper Maranon* and the ironwood sumpitan of the Bornean Dyaks† are similar in every respect, even to the small poisoned darts projected from the weapon. It is impossible that this curious implement of the chase, involving a knowledge of the elastic force of compressed air and the preparation of a deadly vegetable poison, could have been independently invented by rude savages dwelling more than one-third of the earth's circumference apart. The absence of the sumpitan or gravitana in the intervening countries may be considered an objection to their common origin. But the weapons, being only adapted for the sheltered recesses of the forest, would soon fall into disuse in open countries, where the light darts exposed to the wind would be of little account; in these open situations, and for the slaying of large game, the bow and poisoned arrow takes the place of the sumpitan. In the valleys of the Amazon and in Borneo

* "A Naturalist on the Amazon." W. Bates.
† "The Head-hunters of Borneo." Carl Bock.

both weapons are in use, each in its proper place. Amongst rude peoples the use of any particular weapon depends on its being serviceable for procuring food rather than in warfare. The dexterity of the Australian blacks in the use of the spear and throwing-stick is due to its being a weapon of the chase as well as war; and it was "under the greenwood tree" the English archers who fought at Crecy and Agincourt acquired their skill. We can thus understand the disuse of the bow in Polynesia, where the inhabitants subsisted principally by fishing and agriculture.

It could have only been in the remote past, before the isolation of Polynesia, the sumpitan or gravitana crossed the Pacific. In addition to the curious weapon, the denizen of the Brazilian forest country used bark cloth in their scant clothing, and had many customs in common with the natives of the Malay Archipelago, New Guinea, and Polynesia, such as head-hunting, the artificial extension of the ears, the erecting of large buildings to accommodate several families, &c.* As evidences of intermingling, none of these have the same weight as the distribution of the kumara, and of the curious complicated weapon which, in its modified form, the blowing-tube, made from the reeds of the *Carices*, is found as far east as Demerara.†

Although the evidence we possess points chiefly to Polynesia as the route by which Asiatic civilization entered America, it would be wrong to conclude it was the only route. As far north as China and Japan traces of the ancient civilization that spread itself across the tropical islands of the Pacific can be discovered; it is therefore probable that there were at the same period other maritime peoples besides those who colonised eastern Polynesia capable of crossing the great ocean.

Spaniards led the way across the Atlantic to the New World, but they were soon followed by more potent rivals in the work of colonisation. Now, after the lapse of four centuries, though we discover much difference in the results of this colonisation, everywhere American society is decidedly of the European type. Between the arts and institutions of Mexico and Peru at the time of the Spanish invasion there were some important differences coupled with the general resemblance. These differences and the various features in common were exactly what might have been looked for had the countries been colonised during the same era by the agricultural nations occupying the opposite side of the Pacific, from the Malay Archipelago to Japan.

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* "Travels on the Amazon and Rio Negro." A. R. Wallace.
† "Wanderings in South America." C. Waterton.

Art. II.—*An Investigation into the Rates of Mortality in New Zealand during the Period 1881–91.*

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[*Read before the Philosophical Institute of Canterbury, 6th May, 1896.*]

Plates I.-IV.

The following tables, showing the rates of mortality in New Zealand during the period 1881–91, are deduced from the censuses for 1881, 1886, and 1891, and from the deaths for each year during the period.

Generally it may be said that the final tables show a comparison of the numbers living at each age with the deaths occurring at that age. It would have been possible to have computed the tables from one census and the deaths in that census year, but it was considered preferable to use average results, and for this purpose the average population as given by the three censuses has been employed, and the average number of deaths has also been used. In adopting this method there is a greater chance of the final results exhibiting correctly the general mortality of the colony than there would have been had the figures relating to one year only been employed.

The census has never been taken in the middle of a calendar year in New Zealand. In 1881 it was taken on the 3rd April, in 1886 on the 28th March, and in 1891 on the 5th April. This necessitates an assumption being made as to the population living on the 1st July in each year, for the numbers living in the middle of the year have to be compared with the deaths during the year. It was assumed that the population on the 1st July was the mean of the populations on the 1st January and the 31st December. The numbers living in each age-group, as given by the census, were increased in the same proportion as the whole population had increased from the date of the census to the 1st July. This adjustment was made for each of the three censuses, and the total for each age-group found. One-third of these totals gives the average number of persons living in each of the age-groups, as shown in Table A.

No adjustments were necessary for the deaths. One-eleventh of the total number of deaths in each age-period for the eleven years 1881–91 was taken for the average number of deaths, and the results are given in Table A.

It will be observed that the average deaths and average population in Table A are given in groups of five years. The next step in the construction of the final tables is to ascertain the population and deaths at each year of age. The method now generally adopted is that known as Milne's Graphic Method. After a very careful consideration of this method it was decided not to adopt it, but to use instead a mathematical process of distribution based on the method employed by G. W. Berridge ("Journal of the Institute of Actuaries," xiii., 220, and xiv., 244; "Text-book of the Institute of Actuaries," Part ii., p. 465). The results of the distribution are given in Table B. As a test of the smoothness of the distribution, the results were drawn to scale on large diagrams, of which Plates I. and II. are reduced copies.

The population and deaths from 5 to 75 were treated in this way, the figures relating to the first five years of life requiring special treatment.

From Table B the ratio of deaths to population at each age (m_x) is at once obtained, and these ratios are given in Table C.

The probability of living a year at each age (p_x) is derived immediately from m_x by means of the relation $p_x = \frac{2-m_x}{2+m_x}$. The columns headed p_x in Table E, from 5 to 75, were calculated by means of this formula.

The ages 0 to 5 now require consideration. Table D gives the annual births and deaths of children under five years of age for each of the years 1880–92. From these figures, by means of a modification of the method used by Dr. Farr ("Journal of the Institute of Actuaries," ix., p. 134), the probabilities of living a year at each age were determined. The results, after a slight adjustment to make them join smoothly on to the rest of the table, are given in column p_x, ages 0–5, in Table E.

The probability of dying in the year at each age (q_x) is obtained from p_x by subtracting p_x from unity: thus, $q_x = 1 - p_x$.

The next column in the order of formation is the l_x column. Starting with an assumed 10,000 births (l_0), the number surviving the year (l_1) is obtained from the relation $l_1 = l_0 \times p_0$. Similarly the number who reach the age of two alive, out of 10,000 born alive, is $l_2 = l_1 \times p_1$, or generally for any year x, $l_x = l_{x-1} \times p_{x-1}$.

The difference between the number born, l_0, and the number surviving the first year, l_1, gives the number who die in the first year, d_0, or $d_0 = l_0 - l_1$. Similarly for the number who die in the second year, d_1, $d_1 = l_1 - l_2$, and generally for the number dying in the xth year $d_{x-1} = l_{x-1} - l_x$. In this manner the column d_x was formed.

It is not intended in the present investigation to carry these results past age 75, as the available data are insufficient to warrant satisfactory results. It must also be borne in mind that the colony dates from 1840, and the above tables terminate at 1891, consequently all results past age 51 cannot relate to native-born New-Zealanders.

General Explanation of Table E.

Column l_x: This column shows how many out of 10,000 born alive reach each year of age up to 75. Thus, l_{25} (males) = 8,112, and l_{25} (females) = 8,316, or, out of 10,000 males born alive, 8,112 reach the age of 25, and out of 10,000 females born alive 8,316 reach the age of 25.

The two columns l_x for males and females are not strictly comparable, for they do not represent the actual numbers born, but only numbers proportional to them. As is well known, the number of male births exceeds the number of female births. The columns show for each sex how, out of 10,000 born, the numbers gradually diminish.

Column d_x: This column shows the deaths each year out of 10,000 born alive. Thus, d_{25} (males) = 43, and d_{25} (females) = 45, or 43 males die between the ages 25 and 26, and 45 females die between the ages 25 and 26.

Column p_x: This column gives the probability of living a year at each age. Thus, p_{25} (males) = ·9947, and p_{25} (females) = ·9946, or 9,947 males out of 10,000 alive at age 25 survive the year; and 9,946 out of 10,000 females alive at age 25 reach age 26.

Column q_x: This column gives the probability of dying in a year at each age. Thus, q_{25} (males) = ·0053, and q_{25} (females) = ·0054, or 53 males out of 10,000 alive at age 25 die in the year; and 54 out of the same number of females alive at 25 die in the year.

Plates III. and IV. show the results of the life tables graphically. From the column l_x it will be observed that the males are reduced to half the number born between the ages 63 and 64, while it is not till between the ages 66 and 67 that the females are similarly reduced.

The whole of the calculation was done in duplicate, and every care has been exercised to insure accuracy. Some of the results have been checked graphically, results true to four significant figures being easily obtained by this process.

In conclusion, I have to express my thanks to my friend, Mr. Morris Fox, A.I.A., Actuary to the Government Life Insurance Department, for his ever-ready and valuable assistance in the preparation of this paper.

TABLE A.—Average Population and Average Deaths, 1881–91, in Five-year Periods.

Ages.	Males.		Females.	
	Population.	Deaths.	Population.	Deaths.
0–5	42,882	1234·20	41,766	1025 50
5–10	40,348	137·18	39,551	113 09
10–15	34,771	77·09	34,823	74 45
15–20	27,783	103 36	28,167	102 82
20–25	25,172	134 64	24,074	119 36
25–30	24,171	129 64	19,778	113 73
30–35	21,736	136·91	16,227	109 45
35–40	20,258	149 09	14,802	116 00
40–45	19,105	176 64	12,601	104 27
45–50	16,433	200 55	9,897	90 64
50–55	13,365	203·73	7,491	91 73
55–60	7,938	175 00	4,533	74·91
60–65	5,520	168 09	3,409	77·55
65–70	2,968	147 73	2,026	74 45
70–75	1,761	108 82	1,350	72 09

TABLE B.—Population and Deaths for each Year from 5 to 75.

Ages.	Males.		Females.	
	Population.	Deaths.	Population.	Deaths.
5	8,356 2	40 16	8,210 6	33·32
6	8,240·9	32 06	8,082 3	26 17
7	8,098·3	25·81	7,935 6	20 96
8	7,926·6	21 19	7,763·4	17 42
9	7,726 0	17 98	7,568 1	15 22
10	7,497 9	15·96	7,352·2	14·15
11	7,244·4	14 95	7,119·4	13·94
12	6,969·8	14 77	6,873·4	14·42
13	6,679 2	15 23	6,618·5	15 35
14	6,379·7	16·19	6,359·5	16·59
15	5,995 8	17·50	6,048·7	17·97
16	5,729·0	19·03	5,810·5	19·38
17	5,502·9	20·68	5,605 2	20 72
18	5,320·9	22 32	5,428·6	21 90
19	5,184·4	23·87	5,279 0	22 85
20	5,147·3	25 56	5,243·7	23·38
21	5,076·0	26 60	5,105·6	23·81
22	5,021·9	27·29	4,952 1	24.08
23	4,980·3	27·59	4,780·7	24·14
24	4,946·5	27·56	4,591·9	24 00
25	4,951·2	26 25	4,328·2	23 40
26	4,906·4	25·96	4,130 2	23·06
27	4,850·5	25 76	3,942·7	22·78
28	4,775·8	25·74	3,768·1	22·40
29	4,685·1	25·89	3,608·8	22·14

TABLE B.—Population and Deaths from 5 to 75—*continued.*

Ages.	Males		Females.	
	Population	Deaths.	Population.	Deaths.
30	4,527 1	26 62	3,470 8	21 78
31	4,427·7	26 97	3,343·2	21·71
32	4,336 8	27 34	3,230 9	21 78
33	4,256 6	27·76	3,133 2	21·95
34	4,187 8	28 21	3,048 9	22·23
35	4,140·1	28·32	2,988 1	23·14
36	4,090·5	28 92	2,921·6	23·35
37	4,047 2	29 68	2,858·7	23 38
38	4,008 4	30 57	2,797 6	23·24
39	3,971 8	31·61	2,736 0	22·89
40	3,964 9	33 01	2,686 6	22·10
41	3,914 6	34 19	2 613 7	21·52
42	3,849 0	35 36	2,530 5	20 87
43	3,767 3	36 49	2,437·0	20·22
44	3,669·2	37 55	2,333 2	19·56
45	3,513·4	38 64	2,191·2	18·67
46	3,399 5	39 53	2,081·4	18 23
47	3,286 3	40·28	1,975·1	17·97
48	3,173·5	40·87	1,873·4	17 86
49	3,060·3	41·28	1,775 9	17·91
50	3,011 6	41·76	1,716·7	18 79
51	2,868·8	41·70	1,615·2	18 77
52	2,698·6	41·39	1,505·5	18 56
53	2,502 2	40·81	1,388·3	18·12
54	2,283·8	40·04	1,265·3	17·49
55	1,948·8	36·94	1,090 4	15·85
56	1,737·9	35·70	980·1	15·20
57	1,555 9	34·73	887·8	14·77
58	1,406·8	34·02	814·7	14·54
59	1,289·1	33·61	760 0	14·55
60	1,286 0	34·32	769·1	15·31
61	1,199 4	34·10	729 6	15·47
62	1,109·3	33·76	686·5	15·57
63	1,013 6	33·29	638 5	15·62
64	911·7	32·63	585·3	15·58
65	760·2	31 93	496·5	15·42
66	664 1	30 93	448·8	15·19
67	580·6	29 73	397·9	14·90
68	510·1	28·33	359·2	14·61
69	453·0	26·78	328 6	14·33
70	430·4	25·14	320·0	14 10
71	389·3	23·42	295·7	14 01
72	350·5	21·68	270·8	14·14
73	313·5	20·03	245·2	14 53
74	277 3	18 53	218·3	15·21

TABLE C.—Ratio of Deaths to Population at each Age (m_x).

Ages	Males	Females.	Ages.	Males	Females.
5	0048	·0042	40	·0083	·0082
6	·0039	·0033	41	·0087	·0082
7	·0032	·0026	42	·0092	·0082
8	·0027	·0022	43	·0097	·0083
9	·0023	·0020	44	·0102	·0084
10	·0021	·0019	45	·0110	·0085
11	·0021	·0020	46	·0116	·0088
12	·0021	·0021	47	·0123	·0091
13	·0023	·0023	48	·0129	·0095
14	·0025	·0026	49	·0135	·0101
15	·0029	·0030	50	·0139	·0109
16	·0033	·0033	51	·0145	·0116
17	·0038	·0037	52	·0153	·0123
18	·0042	·0040	53	·0163	·0131
19	0046	·0043	54	·0175	0138
20	·0050	·0044	55	·0190	·0145
21	·0052	·0047	56	·0205	·0155
22	·0054	·0049	57	·0223	·0166
23	0055	·0050	58	·0242	·0178
24	·0056	·0052	59	·0261	·0191
25	·0053	·0054	60	·0267	·0199
26	0053	·0056	61	·0284	·0212
27	·0053	·0058	62	·0305	·0227
28	·0054	·0059	63	·0328	·0245
29	·0055	·0061	64	·0358	·0260
30	·0059	·0063	65	·0420	·0311
31	·0061	·0065	66	·0466	·0342
32	·0063	·0067	67	·0512	·0374
33	·0065	·0070	68	·0556	·0407
34	·0067	·0073	69	·0591	·0436
35	·0068	·0077	70	·0585	·0441
36	·0071	·0080	71	·0602	·0474
37	·0073	·0082	72	·0618	·0522
38	·0076	·0083	73	·0638	·0593
39	·0080	·0084	74	·0669	·0701

TABLE D.—Births and Deaths of Children under Five Years of Age.

Year.	Births	Deaths				
		0–1	1–2	2–3	3–4	4–5
		Males.				
1880	9,893	986	183	60	54	31
1881	9,590	987	204	60	49	49
1882	9,712	934	178	82	63	56
1883	9,843	1,079	206	72	57	35
1884	10,131	870	145	77	55	36
1885	10,020	970	176	74	45	31
1886	9,872	1,027	162	56	50	31
1887	9,725	987	154	86	53	27
1888	9,641	752	140	57	36	33
1889	9,514	798	134	57	34	47
1890	9,298	775	114	54	45	42
1891	9,377	942	160	59	31	43
1892	9,101	910	132	77	41	42
		Females.				
1880	9,448	819	174	72	46	33
1881	9,142	744	187	65	57	38
1882	9,297	744	155	71	54	50
1883	9,359	916	190	61	43	36
1884	9,715	708	156	81	41	30
1885	9,678	786	124	57	47	35
1886	9,427	872	152	74	38	30
1887	9,410	808	157	68	48	29
1888	9,261	584	117	58	42	37
1889	8,943	658	116	45	41	23
1890	8,985	663	100	48	20	29
1891	8,896	725	122	47	36	28
1892	8,775	684	112	60	44	31

TABLE E.—New Zealand Life Table, 1881-91.

Males.

x	l_x	d_x	p_x	q_x	x	l_x	d_x	p_x	q_x
0	10,000	967	·9033	·0967	40	7,376	61	·9917	·0083
1	9,033	164	·9818	·0182	41	7,315	63	·9913	·0087
2	8,869	68	·9924	·0076	42	7,252	67	9909	·0091
3	8,801	44	·9950	·0050	43	7,185	69	·9904	·0096
4	8,757	37	·9958	·0042	44	7,116	72	9899	·0101
5	8,720	34	·9961	·0039	45	7,044	77	9891	·0109
6	8,686	31	·9964	·0036	46	6,967	81	·9885	·0115
7	8,655	28	·9968	·0032	47	6,886	84	·9878	·0122
8	8,627	23	·9973	·0027	48	6,802	87	·9872	·0128
9	8,604	20	·9977	·0023	49	6,715	90	·9866	·0134
10	8,584	18	·9979	·0021	50	6,625	92	·9862	·0138
11	8,566	18	·9979	0021	51	6,533	94	·9856	·0144
12	8,548	18	·9979	·0021	52	6,439	97	·9848	·0152
13	8,530	19	·9977	·0023	53	6,342	103	·9839	0161
14	8,511	21	·9975	·0025	54	6,239	108	·9826	·0174
15	8,490	25	·9971	·0029	55	6,131	116	·9812	·0188
16	8,465	28	·9967	·0033	56	6,015	122	·9797	·0203
17	8,437	32	·9962	·0038	57	5,893	130	·9780	·0220
18	8,405	35	·9958	·0042	58	5,763	138	·9761	·0239
19	8,370	39	·9954	0046	59	5,625	144	·9743	·0257
20	8,331	41	·9950	·0050	60	5,481	145	·9736	·0264
21	8,290	43	·9948	·0052	61	5,336	149	·9720	·0280
22	8,247	45	·9946	·0054	62	5,187	156	·9700	·0300
23	8,202	45	·9945	·0055	63	5,031	162	·9677	·0323
24	8,157	45	·9944	0056	64	4,869	172	·9649	·0351
25	8,112	43	·9947	·0053	65	4,697	193	·9589	·0411
26	8,069	43	·9947	·0053	66	4,504	205	·9545	·0455
27	8,026	42	·9947	·0053	67	4,299	214	·9501	·0499
28	7,984	43	·9946	·0054	68	4,085	221	·9459	·0541
29	7,941	44	·9945	·0055	69	3,864	222	·9426	0574
30	7,897	46	·9941	·0059	70	3,642	212	9418	·0582
31	7,851	48	·9939	·0061	71	3,430	201	·9414	·0586
32	7,803	49	·9937	·0063	72	3,229	194	·9401	·0599
33	7,754	50	·9935	·0065	73	3,035	187	·9382	·0618
34	7,704	52	·9933	·0067	74	2,848	185	·9353	·0647
35	7,652	51	·9932	·0068	75	2,663	..	..	..
36	7,601	54	·9929	·0071					
37	7,547	55	·9927	·0073					
38	7,492	57	·9925	·0075					
39	7,435	59	·9920	·0080					

TABLE E.—New Zealand Life Table, 1881–91—*continued.*

Females.

x	l_x	d_x	p_x	q_x	x	l_x	d_x	p_x	q_x
0	10,000	817	·9183	·0817	40	7,498	62	·9917	·0083
1	9,183	155	·9831	·0169	41	7,436	61	·9918	·0082
2	9,028	64	·9929	·0071	42	7,375	61	·9918	·0082
3	8,964	42	·9953	·0047	43	7,314	60	·9917	·0083
4	8,922	33	·9964	·0036	44	7,254	61	·9916	·0084
5	8,889	29	·9967	·0033	45	7,193	61	·9915	·0085
6	8,860	27	·9970	·0030	46	7,132	63	·9912	·0088
7	8,833	22	·9974	·0026	47	7,069	65	·9909	·0091
8	8,811	20	·9978	·0022	48	7,004	66	·9905	·0095
9	8,791	18	·9980	·0020	49	6,938	69	·9900	·0100
10	8,773	16	·9981	·0019	50	6,869	75	·9892	·0108
11	8,757	18	·9980	·0020	51	6,794	78	·9885	·0115
12	8,739	18	·9979	·0021	52	6,716	82	·9878	·0122
13	8,721	20	·9977	·0023	53	6,634	86	·9870	·0130
14	8,701	23	·9974	·0026	54	6,548	90	·9863	·0137
15	8,678	26	·9970	·0030	55	6,458	93	·9856	·0144
16	8,652	28	·9967	·0033	56	6,365	98	·9846	·0154
17	8,624	32	·9963	·0037	57	6,267	103	·9835	·0165
18	8,592	35	·9960	·0040	58	6,164	109	·9824	·0176
19	8,557	36	·9957	·0043	59	6,055	114	·9811	·0189
20	8,521	38	·9956	·0044	60	5,941	117	·9803	·0197
21	8,483	40	·9953	·0047	61	5,824	122	·9790	·0210
22	8,443	41	·9951	·0049	62	5,702	128	·9776	·0224
23	8,402	42	·9950	·0050	63	5,574	135	·9758	·0242
24	8,360	44	·9948	·0052	64	5,439	143	·9738	·0262
25	8,316	45	·9946	·0054	65	5,296	162	·9694	·0306
26	8,271	46	·9944	·0056	66	5,134	172	·9664	·0336
27	8,225	48	·9942	·0058	67	4,962	182	·9633	·0367
28	8,177	48	·9941	·0059	68	4,780	188	·9607	·0393
29	8,129	50	·9939	·0061	69	4,592	191	·9585	·0415
30	8,079	50	·9937	·0063	70	4,401	191	·9566	·0434
31	8,029	52	·9935	·0065	71	4,210	195	·9537	·0463
32	7,977	54	·9933	·0067	72	4,015	204	·9492	·0508
33	7,923	55	·9930	·0070	73	3,811	219	·9424	·0576
34	7,868	58	·9927	·0073	74	3,592	243	·9323	·0677
					75	3,349	..	..	..
35	7,810	60	·9923	·0077					
36	7,750	62	·9920	·0080					
37	7,688	63	·9918	·0082					
38	7,625	63	·9917	·0083					
39	7,562	64	·9916	·0084					

Art. III.—*Australasian Weather-charts and New Zealand Storms.*

By Major-General Schaw, R.E., C.B.

[*Read before the Wellington Philosophical Society, 9th September, 1896.*]

Plate V.

There are three great forces which produce movements in our atmosphere—heat, gravitation, and the rotation of the earth on its axis.

Heat primarily causes motion through the heating of the equatorial zone of the earth by the direct rays of the sun. This heat is communicated to the layer of air in contact with it, which expands, and, being thus lighter than the air not so heated, rises, and the cooler air flows in below. The lighter air flows north and south towards the poles, whence cooler and heavier air flows in to take its place. This is the first and simplest cause of motion in the atmosphere, and it is the result of sun-heat and the attraction of gravitation.

But the rotation of the earth causes the stream of air flowing north and south to diverge from meridian lines. Popularly we see why when we consider that air at the equator is moving eastwards with the earth's circumference—which there is nearly twenty-four thousand miles, or at the rate of a thousand miles an hour—while at the poles there is no eastward motion, and at all intermediate circles of latitude the eastward rate of motion is graduated according to the distance from the equator, that at 60° being just half the equatorial rate. Hence all currents of air flowing towards the poles are moving also more and more quickly than the surface of the earth towards the east, and they seem to be from the west of north or south, while all currents of air flowing from the poles towards the equator are also apparently moving in the reverse direction, from the east of north or south; because, as they advance equatorwards, the surface of the earth is moving more and more rapidly to the east, and the currents of air lag behind. But the mathematical law is more complete than this—viz., that in the Southern Hemisphere, between the equator and the poles, any body freely moving over the surface of the earth in any direction appears to be deflected to the left, and, in the Northern Hemisphere, to the right, the amount of deflection varying directly as the sine of the angle of latitude. Hence the deflection is much greater at the antarctic circle than it is, say, in our latitude. This is important for us to bear in mind when we come to

consider the probable causes of the motions of the atmosphere in cyclones (or "lows") and anti-cyclones (or "highs").

Heat, however, has an additional influence on the motions of our atmosphere, on account of the vapour of water which is present so largely in the atmosphere. Vapour of water contains a considerable amount of heat in an imperceptible or latent condition. This heat has been abstracted from the wet surface where the evaporation takes place (a fact well known to us by the chill experienced as our skin dries when wetted), and it is given up again when the vapour is reconverted into water by reduced temperature and pressure. Thus the apparent anomaly results that the cool air saturated with vapour which the westerly winds bring over our Southern Alps loses there its moisture—condensed into rain and snow—and passes on as the warm, or even hot, dry wind experienced in the plains of Canterbury. Under suitable conditions this setting-free of the latent heat in water-vapour by condensation gives rise to ascending currents in temperate or cold regions like those produced directly by the sun's heat in the tropics, or in localities where the character and configuration of the surface of the ground causes an abnormal heating of a portion of the surface of the ground, and so of the air in contact with it. This latter condition of things is believed to be the cause of most of the comparatively small, but very violent, tornadoes experienced in tropical regions—in America, and Asia, and other places exposed to great heat from the sun's rays. The former is thought to be one of the main causes of those more widely-extended but generally less violent storms experienced in the temperate zones.

We see, then, two or three classes of circulation in the earth's atmosphere. First, the constant great exchange between the equatorial and polar districts, which, modified by the rotation of the earth, causes the trade winds north and south of the equatorial belt of calms, the two belts of comparative calms and high barometer in the vicinity of the 35th parallel of latitude north and south, and the counter-trades on the polar sides of these belts. Secondly, the constantly-recurring phenomenon of circular storms moving eastwards in these regions of the counter-trades. And thirdly, the occasional tornadoes or hurricanes which are met with in the tropics. It is with the second class of disturbances that I propose to deal this evening, by the aid of the charts of Australasian weather prepared day by day at Brisbane under the superintendence of Mr. Wragge, the Government Meteorologist there, and sent regularly to Sir James Hector, who has kindly placed them at my disposal.

I believe that it is mainly owing to the energy, zeal, and scientific knowledge of Sir James Hector himself that we are

indebted for the initiation of this system of weather observations and weather-charts, although it so happens that the Governments of Queensland and South Australia, and more especially the former, have been most wisely liberal in providing sufficient funds for maintaining an efficient meteorological department of State.

Before proceeding to discuss these weather-charts, however, I wish to draw your attention, first, to the schematic representation of the general circulation of the atmosphere given in the diagram (Pl. V.), and to the general theory of cyclones and anti-cyclones, premising that on both subjects we are far from having attained to accurate knowledge, or to a general consensus of opinion.

Starting at the equatorial belt of calms, which, you will observe, lies north of the equator, we see the upper current flowing over towards the poles, while a cooler under current in the opposite direction flows towards the equator to replace the other. This cool current, deflected to the left, as before mentioned, causes the south-east trade winds in this hemisphere.

At about 35° latitude the upper current flowing pole-wards is met by an opposite upper current flowing towards the equator, and in this region lies the belt of comparative calms and high pressure with anti-cyclonic circulation (*i.e.*, against the hands of a watch in this hemisphere), and the currents reappear near the surface of the earth, flowing out from the calm belt north and south. That flowing north, in this hemisphere, or towards the equator, we have already noticed as the south-east trade winds; that flowing towards the southern pole, deflected to the left or eastwards, produces the "brave west winds," "the roaring forties," or the "counter-trades" so well known to navigators. In the higher atmosphere above these westerly winds a reverse current exists flowing northwards towards the equator: and here our fairly-certain knowledge ends; but there are strong grounds for believing that the general circulation is completed as shown in the diagram, an upward circulation taking place at about the 60th parallel of latitude, with a very low barometer when the opposing low-level currents meet, just as the downward circulation with a very high barometer occurs at the meeting-place of the high-level currents near the 35th parallel of latitude. Beyond this is pure conjecture at present; but reason leads us to believe that the high currents from all sides meet in the region of the pole, causing anti-cyclonic calms and high pressure there, and a vigorous outflow on all sides at a low level. This appears to be the vertical or meridional system of general circulation.

As regards the two contrary and apparently supplementary systems of circulation in a horizontal, or, rather, gyratory,

manner observed in the anti-cyclones and cyclones, no thoroughly exhaustive theory has yet been established to account for them. Yet these two systems are practically invariable in each hemisphere, and in reverse directions in the two hemispheres. It is clear, therefore, that they depend on fixed laws, however complicated those laws may be owing to the extreme variability of the behaviour of the atmosphere under different conditions of pressure, of temperature, and of moisture; and, also, it is evident that the rotation of the earth rules the directions of their rotation.

In a popular way we may perhaps regard the phenomena of the anti-cyclones in this way.

The total mass of air between the equatorial belt and the calm belt near 30° latitude is about equal to the total mass of air between that belt and the pole, hence the opposing currents must meet in that zone. As they form the upper strata of the atmosphere, with very little pressure from superincumbent air, that current which is in any degree lighter than the other rises and rides over it, compressing and forcing down the other; and this process of one stratum gliding over another is being constantly renewed by fresh air pressing on behind from the opposite sides. But this sandwiching of opposing currents and their piling up above one another must reduce their onward velocity and increase their tendency to deflect to the left, while at the same time they are being pressed downwards; it follows that, as the fronts of these successive layers of air, after passing over or under the front edges of the opposing layers, are turned to the left and downwards, a downward screw-like circulation to the left (or against the hands of a clock) is set up and maintained. The level at which the outflow of air takes place, and the principal direction of that outflow, depend on the pressures in the vicinity, the principal outflow being towards the centre of lowest pressure. Thus in some measure cyclones are supplementary to anticyclones, forming, as it were, drainage-basins for their outgoing air. Yet there is no permanent connection between the two circulations. Rather, apparently, does the cyclone attack the anti-cyclone, which offers a more or less passive resistance to its onward movement.

The Hon. Ralph Abercromby distinguishes two classes of cyclones which reach England—those born at the edge of the anti-cyclone tropical belt and moving north-east, and those born in the arctic regions and moving south-east. Ours seem to correspond with the latter.

The theory of the cyclonic circulation—of the birth and of the progress of cyclones such as we experience in these latitudes—is still in its infancy. Yet, as the direction of the circulation is invariable (with the hands of a watch in this

hemisphere), and as the motion of translation is uniformly to the eastwards and northwards, although frequently obstructed, or even reversed, for a time by opposing anti-cyclones, it is clear not only that the circulation is according to law, but also that the maintenance of the circulation, and also of the onward march, it may be, are due to some force developed within the cyclone itself. The origin of a whirlwind in a hot region is simple. Some locality under special conditions gets excessively heated by the sun, and an upward current is produced. From all sides cooler air flows inwards and upwards, and so a spiral upward motion is produced, either right-handed in this hemisphere or left-handed in the Northern Hemisphere. But what is the cause of our cyclonic storms, which reach us from the west and apparently from the south? They cannot be due to any such superheating of the ground, for all is sea until we reach antarctic ice-clad land. I put forward the following suggestion, partly derived from the ideas of various writers on the subject and partly from my own ideas.

I conceive that our cyclones have their birth on the confines of the antarctic region—at the meeting-place of the north-west counter trade-winds with the low-level outflow from the south polar anti-cyclone. Where these opposing currents meet they cannot glide one over the other as in the case of the high-level currents which form anti-cyclones, because of the presence of the superincumbent atmosphere; therefore they form a calm neutral mass between them, and by the constant pressure both are forced upwards, each being deflected strongly in this high latitude to the left, outside the calm column of air, and so producing the right-handed upward spiral, in which motion the central column itself may partake. But as the air ascends temperature and pressure decrease, until the water-vapour is condensed into rain or snow or hail, and the latent heat is given up to the surrounding air, which expands and rises, and causes a stronger upward draught. This condensation and liberation of latent heat would be greatly accelerated by the presence of snow-clad land at the meeting-place of the winds, and it may be that in some favourable spots on the coast-line of Antarctica high cliffs and glaciers meet the force of the vapour-laden west winds and act as the primary determining influence by forcing the west winds upwards, and, by condensation of the vapour and consequent warming of the air, increasing the upward current. At the level of the surface of the land the force of the opposite current would be felt, causing first gyration and then northerly motion of the whole gyrating system, which would be borne eastwards and northwards by the prevailing westerly winds—northwards because the southern edge of the storm-whirl is circulating against the west wind while the northern edge is circulating

with it, hence the pressure is greater on the south than on the north, and the whole system is forced northwards as well as eastwards. As this upward whirl moves over the ocean it is constantly sucking up water-vapour with the air which enters it below. This is condensed in its turn as it rises into regions of lower pressure and lower temperature, forming clouds, rain, hail, or snow, and liberating more heat, and so giving fresh force continually to the ascending current. The ascending currents must be strongest on the north and east, which are fed by warm air, and less strong on the south and west, which are fed by cold air; and this, probably, is the chief cause of easterly and northerly motion.

Our circular storms act as immense irrigating and warming machines, pouring out over sea and land the water taken up as vapour, and diffusing the heat in the upper air originally communicated by the sun to the upper layers of the ocean, while at the same time they mix and purify the air. These rotary storms are frequently met with by vessels navigating the ocean south of the belt of anti-cyclones and high pressure. Captain Maury collected an immense number of statistics on the subject, which place it beyond doubt that they occur frequently at least as far south as 50° or 55° S. latitude, where, although west winds prevail, east winds sometimes occur.

In our latitudes they generally first become apparent to our observation in the neighbourhood of Cape Leuwin, whence they advance eastwards along the border of the belt of anti-cyclones, sometimes as rapidly as twelve hundred miles in the twenty-four hours, or fifty miles an hour, sometimes much more slowly. Sometimes they are stopped or even recede for a time, apparently being resisted by the anti-cyclones. Sometimes they partially break through the barrier northwards, but never completely, as far as I have been able to ascertain. Most frequently the storms pass south of New Zealand; but very frequently they extend as far as Cook Strait, through which they pass. More rarely they extend to the north of the North Island, in which case they generally present the normal type of a completely closed circulation, while those that pass south of Wellington usually present the appearance of a partial circulation open to the south. Probably this is frequently due to our having no observatories farther south to record the variations of barometric pressure and of the direction of the wind; but sometimes the circuit may be open to the south, as is the case occasionally in North America towards the north. Always it is to be observed that our great mountain-ranges largely influence the form and progress of the storm circulation, and it would seem also that over the ocean the progress and extension northwards of the depres-

sion is much more notable than over the land. This last observation, if established, would seem to favour the view that the inherent force of the storm is due to the vapour of water drawn up from the sea, which gives out its latent heat when condensed in the upper strata of the atmosphere.

Occasionally the first appearance of one of these depressions is near Tasmania. I have not yet found in the records more than one case where it first appeared at New Zealand. This leads one to suppose that there is some special nursery for storms on the shores of Antarctica, whence one after another is constantly being launched on their ocean voyage. How far a storm can travel before it ceases to maintain its rotary character is yet, I think, uncertain, but a few cases are recorded where the same storm seems to have been traced halfway round the globe.

In this Southern Hemisphere circular storms seem to be more regular and persistent than in the Northern Hemisphere, which probably is due to the smaller interference of land in this hemisphere. The trade winds and counter-trades are more powerful in the Southern than in the Northern Hemisphere. The whole air-circulation is freer and more active, and probably this is the main cause of the displacement northwards of the equatorial belt of calms. Cyclones are generally now called "lows," because the barometer shows a low pressure of the atmosphere towards the centre of a cyclone circulation, and the anti-cyclones are called "highs" for the contrary reason.

Now, we have every reason for believing that when a cyclone borders on an anti-cyclone the surplus air from the anti-cyclone pours down into the cyclone, and yet that the circulation within the anti-cyclone is screwing downwards and that in the cyclone is screwing upwards from below.

We conceive, therefore, that, as air-motion depends on gravity (apart from the motion due to the rotation of the earth), the altitude of the plane where the air leaves the anti-cyclone must be above the level of the plane where it enters the cyclone. The latter appears to be at the level of the earth's surface, and for an unknown height above it. Evidently, if the cyclone is not filled up, and so quenched, the air pouring in must escape upwards and outwards, and this we believe it does, while the anti-cyclone is replenished by air pouring in from above. Now, if the level of the atmosphere above the anti-cyclone be above the average level of the atmosphere, what force causes the surrounding air to rise up and flow down into it? To this I can find no answer in books, although some German meteorologists attribute it to the rotation of the earth. Hence it appears possible that really the true height of the column of air near the 35th

parallel of latitude is below the average, and that the high barometer, or greater atmospheric pressure, there is due to the downward motion of the air rather than to the greater height of the column of air. Similarly it may be that the comparatively low barometer near the equator, and the very low barometer near the antarctic and arctic circles and in the centres of rotating storms, may be due to ascending currents of air there rather than to a lower level of the surface of the atmosphere. Should this be as I suppose — namely, that the general level of the surface of the atmosphere is higher at the equator and towards the poles than it is near the 35th parallel of latitude—the circulation would take place, as we know it does, according to the laws of gravity. The velocity acquired by the air sliding down two inclined planes from the equator and polar regions and meeting about the 35th parallel would produce the downward movement there, made gyratory by the rotation of the earth.

The friction of one stratum of air gliding over or beside another stratum of air has been found to be infinitesimally small, so that the velocities of two such bodies of air moving from north and south, and meeting about the 35th parallel, would be the final velocities attained by the accelerating force of gravity at this point, and the collision would cause the masses to fall with the momentum produced by the vertical components of their onward and downward motions.

Is not the high pressure observed in an anti-cyclone due—in part at least—to this downward momentum? And similarly, is not the low pressure observed in a cyclone due—in part at least—to the upward motion produced primarily by collision of oppositely-flowing currents of air under the influence of gravity, and sustained by the latent heat set free as the vapour of water in the subtropical inflowing current of moist air is condensed by the opposing polar cold current? I suggest the question, but I am unable to assert that the facts are as I suggest.

I do not think that any good instrument has yet been devised for registering the upward or downward movements of the wind. Such instruments installed at high levels and at low levels would give us, I believe, much valuable information on this very obscure subject.

As regards the interaction of cyclones and anti-cyclones upon one another in such cases as we observe here, it will be evident that, whatever be the full causes of the high and low barometers in the two systems, they tend to destroy one another, the high filling up the low and the low eating up the high, and both being thus reduced towards the normal pressure. But it is a question of supply and demand. When an anti-cyclone is bordered on both the north and south sides

by cyclones it generally is rapidly diminished in extent and pressure, and the lows advance towards each other; but if this advance of the lows be across Australia they soon shallow and die out—as I conceive, because their inherent force, the constant condensation of vapour of water, is lost in that arid land. Sometimes a large cyclone with very low pressure will rapidly diminish an anti-cyclone with which it collides; sometimes the regular supply to the anti-cyclone from above seems to exceed the drain upon it by the cyclone, and it either is undiminished or increases.

If the high be north of the low—the most common case—the effect of the outflow from the high into the low will be to increase the motion eastwards of the latter, owing to the eastward deflection due to the rotation of the earth. If the high be east of the low the tendency will be to retard the motion eastwards and to deflect the low to the south. If the high be south of the low it will retard its progress; if west of the low it will accelerate its progress and deflect it northwards. These theoretical results seem to correspond generally with the facts shown by the weather-charts.

In considering the two series of Australasian weather-charts which exhibit types of winter storms and summer storms, we observe, first, the belt of calms and anti-cyclones to extend generally farther north in winter (10° to 45°) than in summer (25° to 45°), and thus to be wider in winter than in summer; secondly, that it is broken up into a series of anticyclonic circulations, all circulating from north by west to south and from south by east to north; thirdly, that these anti-cyclones seem to be mobile and pliable, yet without any decided tendency to move east or west along the belt, while they appear to offer great resistance to the movements of cyclones.*

The cyclones generally seem to lose their force when passing over land, and to increase in force over water. They have a powerful energy of motion in an easterly and northerly direction, which, when unopposed, may carry them twelve hundred miles in twenty-four hours; but they are often checked, or even for a time forced back, by opposing anticyclones. They rapidly alter their forms, throwing out great arms of depression where the resistance is diminished by

* It is to be noted that ordinarily, as each successive cyclonic disturbance appears on the south west coast of Australia, it is accompanied by an anti-cyclone following it on its north-west side, which travels across Australia as the cyclone progresses eastward along the south coast, until the Tasman Sea is reached. There a comparatively permanent anticyclone exists which is attacked by each successive cyclone, and with its remains the following anti-cyclone blends and restores it to its normal condition as the cyclone passes on eastward.

straits or by the absence of anti-cyclones, or highs. These arms sometimes appear to break off and form separate cyclones; and sometimes a cyclone stopped by a high in front of it may be overtaken by a succeeding cyclone, which coalesces with it, and the increased energy thus obtained forces a passage for the combined system. In summer the cyclones appear generally on the south coast of Australia, farther to the east than in winter; they are less frequent, and travel somewhat slower. In winter they appear usually as a depression off Cape Leuwin, and they travel to New Zealand—about three thousand miles—in from six to twelve days—in one instance three days—or at the rate of about five hundred to two hundred and fifty miles a day including stoppages, and they succeed each other at the rate of about one in every six days. In summer they travel at about four hundred to two hundred miles a day, and they do not usually occur more frequently than once in twenty days.

We can see a reason for this in the greater difference of temperature during winter than in summer between the equatorial and the polar regions, and the consequently more rapid and vigorous circulation of air between them in winter than in summer.

To one other point I would draw attention, in conclusion. We have seen that the great circulating systems of depression appear to travel from west to east, and sometimes with great velocity. But the force of the wind does not appear to be influenced by this eastward movement of the systems; the force of the wind depends apparently on the velocity of circulation, not on the rate of translation. We must think, therefore, that the eastward movement of translation, and the corresponding movements north or south of these depressions, are of the nature of wave-motions, not of horizontal motions of the particles of the atmosphere. Such wave-motions are not easily conceived, and they must be very complicated. Fresh particles of the atmosphere are constantly being drawn into the vortex and whirled upwards and outwards as the storm moves on, and the force of the wind depends upon the vigour of this circulation, not on the rate of its propagation.

The whole subject is extremely difficult. The enormous forces influencing winds and weather have been in operation for thousands of thousands of years performing the beneficent designs of the Creator, and men hitherto have known little or nothing of the how. Within late years careful systematic observation has given us some little insight into the modes of operation, and I have no doubt that by degrees we shall learn more perfectly the laws governing our weather, and be able more accurately to forecast the immediate future; and that we shall understand better than we do now where and how

our storms arise, what is their motive-force, and what circumstances govern their direction and rate of progress. But in this, as in all true science, our knowledge must be based on long-continued, careful observation and comparison of facts.

Some of these facts I have endeavoured to bring before you this evening. My own study of them has given me great interest and pleasure, and I hope that in some small degree I may have been able to communicate to you some of that interest and pleasure.

The charts exhibited were those extending from the 23rd December, 1895, to the 9th January, 1896, showing a typical summer storm, which first appeared in the Great Australian Bight on the 23rd December, and the progress eastward of which was traced day by day until it reached New Zealand on the 3rd January, when for four days a north-westerly gale prevailed, followed by a day of moderating west-by-north wind; then, on the 8th, southerly squalls; and on the 9th the storm had passed, and fine weather, with southerly breeze, prevailed. The charts showing the rise, progress westward, and termination of a tropical storm between New Caledonia and North Queensland were also exhibited.

New Zealand winter storms were illustrated by a series of charts extending from the 13th June to the 13th July, during which period five storms passed over New Zealand, some of them south of the South Island, some through Cook Strait, and one in a completely-closed circuit passing north of New Zealand; all having been traced from their first appearance near Cape Leuwin. In some cases succeeding storms overtook and became blended with the preceding storms.

Examples were also shown of various other storms in which the southern portion of the circuit, with its easterly winds, was more or less completely exhibited near New Zealand.

ART. IV.—*A Comparison between the Animal Mind and the Human Mind.*

By CHARLES W. PURNELL.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1896.*]

IN order to form anything like a definite notion of the animal mind, we must, so to speak, begin at the beginning. We must look back to the days when animal life originally appeared upon the earth, and consider what were the probable mental powers of the first animal, or the first set of animals,

which came into existence. This might seem an inquiry of so purely speculative a character as to be valueless for scientific purposes, but a little reflection will show it to be otherwise. The animals now existing are physically the products of long series of ancestors, and owe their bodily structure either to the modifications which their predecessors underwent from the influence of their surroundings, or to the vitality which enabled them to more or less successfully withstand that influence.

Now, whatever view we may take of the nature of the animal mind, it evidently bears a very intimate relation to the animal's bodily structure, which, in its turn, depends upon the animal's manner of life. For example, all beasts of prey are of a fierce and cruel disposition. They are daily engaged in slaughter, and frequently in struggles in which they must either kill or be themselves either killed or injured. They cannot procure a meal without destroying some other creature. It is impossible for the milder qualities of mind to develope under such circumstances. Courage, ferocity, wariness, and cunning become prominent features in the animal's disposition, while considerable powers of strategy are often evoked. Thus, Sir E. Tennant, in his "Natural History of Ceylon," writes, "At dusk and after nightfall a pack of jackals, having watched a hare or a small deer take refuge in one of these retreats, immediately surround it on all sides; and, having stationed a few to watch the path by which the game entered, the leader commences the attack by raising the cry peculiar to their race, and which resembles the sound 'okkay' loudly and rapidly repeated. The whole party then rush into the jungle and drive out the victim, which generally falls into the ambush previously laid to entrap it." How strikingly different are the mental dispositions of animals of this kind from those of many birds, which manifest a gay and lively temperament, seeking amusement in song or dance, or even, like the bower birds, in constructing bowers and playhouses, adorned with gaily coloured feathers, shells, and other articles, in which to disport themselves. Equally unlike are their bodily frames, which, in either case, are fitted for the animal's daily pursuits. The body of the beast of prey is constructed strongly enough to enable it to hold its own in the desperate struggles in which it is constantly engaged, while the song-bird, on the other hand, possesses a lightly formed body, which seems to be the physical expression of its gay and volatile mind. Hence the fossil remains of extinct animals, while teaching us the nature of their bodily structure, also enable us to deduce inferences of much importance concerning their mental endowments.

There are four aspects in which the apparently intelligent

actions of animals can be viewed. We may regard the animal—(1) As being mentally an automaton; (2) as possessing a mental constitution fundamentally different from man's, but, since we are unable to conceive the precise nature of the animal mind, we interpret it in terms of our own consciousness; (3) as possessing a mental constitution similar in some respects to man's, but also containing elements not found in the human mind; (4) as possessing a mental constitution fundamentally akin to man's, but differing in degree, and of a lower type of development.

The first view was advocated by Descartes; but the stores of information upon the subject of animal intelligence which have been garnered during the last quarter of a century render this theory so improbable that I think it is unnecessary to discuss it. The second view is more debatable. The absolute want of articulate language among the lower animals renders it impossible for us to directly communicate with them except by signs and tokens. A dog may learn to obey the spoken order of its master—it may come to associate a certain sound uttered by the latter with some act to be done—but its master cannot acquire any knowledge of what is passing in the dog's mind except by drawing inferences from the dog's actions; while these inferences are based upon the assumption that, if a human being possessed the same kind of body and were placed in the same circumstances as the dog, that human being would express certain feelings or ideas by the acts done by the dog. A dog sees a friend approach and wags its tail; its master concludes that the dog is thereby expressing its pleasure. Why? Because the master unconsciously infers that if he were the dog and wished to express pleasure he would do so in that fashion. All our ideas about the animal mind and the animal's actions are anthropomorphic, for the simple reason that it is beyond our power in the present state of our knowledge to summon up ideas of any other nature. We even clothe our fellow-men with our own individuality. None of us knows any other human being exactly as that human being is. We construct our own mental image of him. The late Professor Clifford described the mental images thus formed as being "ejects" of the minds of the persons forming them. Oliver Wendell Holmes, in his "Autocrat of the Breakfast Table," has put the matter in a less precise and scientific, but more easily comprehensible, way when he says that in a dialogue between John and Thomas there are three Johns taking part in it—(1) the real John, known only to his Maker; (2) John's ideal John, never the real one, and often very unlike him; and (3) Thomas's ideal John, never the real John, nor John's John, but often very unlike either. Hence it is not impossible that the

second view is the correct one; but, inasmuch as we can neither prove nor disprove it, and as I think the balance of probabilities lies in another direction, I shall pass it by; only it ought to be always kept in mind as a conceivable solution of the question.

I shall deal with the other two aspects of the case together, and consider how far our present knowledge enables us to form an opinion upon their accuracy or otherwise.

The first bond between the animal and the human being, mentally speaking, which arrests our attention is the possession by every animal, as by every human being, of a separate personality. We are so accustomed to take this separate personality for granted—at all events, as regards the higher animals—that we overlook the full significance of the fact. Moreover, while we may readily concede that the higher animals possess independent personalities, we may find it harder to believe that more lowly creatures, like, say, the medusa, are equally distinct personalities. Yet one simple consideration will prove such to be the case. All animals, however lowly in organization, possess consciousness. The possession of consciousness is the essential distinction between an animal and a plant. The latter is endowed with excitabilities, and may even be said to possess discrimination, since it is able to select from the soil material which will serve for its nourishment and to reject that which will be injurious to it or useless for its support; but it does not possess consciousness. Now, what is consciousness? It is a *revelation* to something which in man is called by metaphysicians the *ego*, or self. What the *ego* is we do not know; but we do know that, so far as man is concerned, the *ego* of each individual being is distinct from the *ego* of every other, and is capable of cognizing. Consciousness, too, is not identical with mental operations, which may go on in our minds without our being conscious of them. It is, so to speak, an event, a manifestation of mental operations to the *ego*, and it is only to the *ego* that consciousness appeals. Here, however, I am getting into intricate paths, and shall go no farther. My argument is, shortly, that, inasmuch as all animals are gifted with consciousness, else they would not be animals, they must also possess an *ego*, because, while we can imagine an *ego* existing without consciousness, we cannot imagine consciousness without an *ego*.

Palæontology teaches us that the earliest forms of life were of a simple character, and that, speaking generally, the organization of the animal kingdom has increased in complexity from the time when living creatures first appeared upon the earth up to the present day, when it has attained a more varied and complex development than at any previous epoch. We cannot, however, point to any particular form of animal

life and say, "This is the first kind of animal which appeared upon the globe," because in the oldest geological formation in which undisputed animal remains occur—viz., the Cambrian—they are found in such profusion, and are the remains of animals of such high organization in their respective classes, as to lead to the irresistible conclusion that they are the descendants of long lines of ancestors of presumably simpler organization. Such, I believe, is the opinion of most if not all competent palæontologists; and, reviewing the facts concerning the gradual development of animal life upon the earth with which we are acquainted, and the reasonable inferences which may be drawn from them, I think we are justified in concluding that all animal life originated from an exceedingly simple form, possibly even simpler than the amœba.

Reverting, then, to this primordial form, I invite you to regard its mind as being as primitive as its body, and destitute of any impressions or notions of the outer world, but nevertheless capable of receiving and absorbing such impressions through the medium of its body. Whether mind is a separate entity from the body, or whether, as the Monists contend, mind and body are the same, but viewed in the one case from its metaphysical in the other from its physical side, it is needless for my purpose to discuss. The view which I propound is that when a living creature first appeared upon the earth its mind was, so to speak, a blank, but possessed the capacity of receiving through the body with which it was associated impressions from the outer world, and of storing and transmitting such impressions to its descendants. In process of time the primitive animal form developed in a vast variety of directions; it acquired new organs, new powers, new senses. The mind of the animal grew *pari passu* with it. Generation after generation the animal mind became charged with fresh impressions until it grew in many instances into a composite structure, formed from the impressions of the outer world, which it derived through the medium of the gradually-evolved organs of sense, combined with the hereditary predisposition to certain habits which it acquired through successive generations of the body pursuing more or less similar modes of life. That the development of the mind of the animal must necessarily coincide with the development of the body will be perceived upon a little reflection. Consider, for example, what a wonderful difference to the mind of an animal perfect vision must make. An animal like the amœba, destitute of organs of vision, and which, if it perceives light at all, probably is merely able to distinguish light from darkness, or the medusa, whose organs of vision are of the simplest kind, must necessarily receive impressions and form ideas of the external world of a radically different nature from those formed by

a keen-sighted creature like the eagle, and the mental activities thus awakened must be fundamentally different. The great mental influence exercised by the organs of vision is, I think, proved by the extraordinary size of the optic lobes in the lower animals compared with the other parts of their brains; and wherever we meet with an animal displaying great mental activity we find it accompanied by a corresponding perfection of the optic sense. The cephalopods, of all molluscs, exhibit the highest intelligence, while their eyes are more perfectly constructed than those of any other member of this sub-kingdom. Then, too, particular senses are specially developed in certain animals. In the dog the sense of smell has acquired a preponderance, and, as has been said, to a dog the world is a world of odours. It recognises by odours what many other animals can only recognise by sight. With animals like the antelope, the light and slender structure of the body, which renders the animal unfit to do battle with its enemies, is accompanied by a corresponding timidity of mind, an alertness of disposition, and a quick apprehension of danger. Descending to the insects, notable illustrations are to be found of the correspondence of the animal body with the animal mind. Specialisation of bodily functions has here been carried to an extreme pitch, with the result that many of these little creatures have developed remarkable so-called instincts. Their bodies have become fitted for special narrow habits of life, which these animals pursue for generation after generation with unvarying monotony. Among the termites, or white ants, there are four different bodily forms in the same species—viz., males, females, workers, and soldiers, all of which fulfil their well-defined and independent functions in the communal organization, and never interfere with the functions of one another. The result is a perfect order and harmony in co-operative working which, at first sight, strikes the beholder with astonishment, and leads to the inference that these little animals are gifted with exceptional intelligence. Similar phenomena are exhibited by the true ants and the bees—the structure and provisioning of whose dwellings, and the methodical character of whose social system, have evoked the admiration of many an observer and writer. I think, however, the intelligence of these insects has been somewhat overrated. Their minds and bodies alike move in narrow grooves, and both have attained a certain pitch of perfection within the limits of those grooves, but their mental powers cannot be regarded as of as lofty an order as those of animals whose "instincts" may be less perfect, but which are capable of accommodating their actions at any moment to suit the varying exigencies of their lives.

The preservation of animal types seems to depend mainly

upon successive generations experiencing the same conditions of life. If an ancient type is suited to its surrounding conditions, and those conditions remain unchanged, while the animal is able to protect itself against enemies, the type may remain unchanged for an indefinite length of time. This is well seen in the case of some marine brachiopods. Thus the genera *Lingula* and *Discina*, which are still abundant in modern seas, are also found in the Cambrian rocks, and the Cambrian forms are practically undistinguishable from the modern. So the genus *Terebratula*, which first appeared in the Devonian formation, is still extant. Other instances might be quoted, the interpretation of the extraordinary persistence of such types, compared with the rise and fall of others, being, I believe, due to the fact that these particular forms of life have never been subjected to the unfavourable changes in the environment which other forms have been required to meet, and to which the latter have succumbed. We may fairly assume that the mind of the Lingula, like its body, has remained practically unaltered since the Cambrian epoch. Many millions of years have elapsed, but the race has neither progressed nor retrograded, whether in body or in mind.

Other creatures, however, have been forced into severer struggles for existence; new bodily forms have thus been evolved, and fresh mental developments taken place. Stores of inherited memories have been accumulated, and fresh mental capacities evolved. The minds of different orders of animals have followed different lines of development, just as their bodies have done. The starling and the worm which it captures may owe their origin to a common ancestor in the far distant past; but how unlike their bodily structure, and how different must be their mental organization! It would seem as if the various orders of animals had their broad mental specialities, although our present knowledge of the subject is too vague to enable us to fully comprehend those specialities. To illustrate my meaning I will refer to the development of the æsthetic sense in birds. That birds take extreme pleasure in singing is manifest. Their songs are more than ebullitions of overflowing spirits. Birds evidently appreciate each other's vocal efforts. The male bird frequently sings to the female while the latter is incubating. The New Zealand saddleback, which is naturally a noisy bird, is one of them. Sir Walter Buller says that during the breeding season the male performs to his mate in a soft tone of exquisite sweetness. The pleasure, however, which the female derives from these displays must be regarded as more of a sensual than of an intellectual nature; but many birds seem to rejoice in singing for its own sake, and to be able to criticize the excellence

or otherwise of each other's vocal performances. Charles Darwin, in the "Descent of Man," relates a striking case which was communicated to him by a competent observer of a bullfinch which had been taught to pipe a German waltz, and was otherwise a superior songster, being let into a room where other birds were kept. As soon as the bullfinch began to sing all the other birds, consisting of some twenty linnets and canaries, ranged themselves on the nearest sides of their cages and listened with the utmost interest to the new performer. That birds often pride themselves upon their vocal performances, and try to excel one another in this respect, is known to every observant person who has kept canaries and finches. Indeed, they occasionally seem anxious to display their vocal superiority over birds which, to a human being, could not possibly be their rivals in song. A friend of mine told me the other day that his canary had just been evidently trying to "sing down" a sparrow chirping from a neighbouring bush. Certain birds, too, including our New Zealand bell-bird, sing in concert. Vocal displays of this kind are devoid of the sexual element, and indicate the existence in birds of a faculty of refined enjoyment which can hardly be distinguished in kind from the æsthetic faculty in man.

Other actions of birds lead to the same conclusion. The jacana, a South American rail, says Hudson, goes through "a remarkable performance which seems specially designed to bring out the concealed beauty of the silky, greenish-golden wing quills. The birds go singly or in pairs, and a dozen or fifteen individuals may be found in a marshy place feeding within sight of each other. Occasionally, in response to a note of invitation, they all in a moment leave off feeding and fly to one spot, and, forming a close cluster, and emitting short, excited, rapidly-repeated notes, display their wings like beautiful flags grouped loosely together: some hold their wings up vertically and motionless, others half open and vibrating rapidly, while still others wave them up and down with a slow, measured motion." Both sexes take part in these displays; but, in the case of another South American bird, the gallo, or cock-of-the-rock, the males alone assemble in numbers at certain spots in the forest and dance two or three at a time before the rest. The dancing parties, or "sacaléli," of the paradise birds in their native forests, of which a vivid description has been given by Wallace, may also be noticed. The birds choose for the purpose certain trees "which have an immense head of spreading branches and large but scattered leaves, giving a clear space for the birds to play and exhibit their plumes. On one of these trees dozen or twenty full-plumaged male birds assemble together,

raise up their wings, stretch out their necks, and elevate their exquisite plumes, keeping them in a continual vibration. Between whiles they fly across from branch to branch in great excitement, so that the whole tree is filled with waving plumes in every variety of attitude and motion." Wallace describes the manner in which the bird spreads and expands its plumes, and remarks that, "when seen in this attitude, the bird of paradise really deserves its name, and must be ranked as one of the most beautiful and most wonderful of living beings."

Other examples might be given of the habits of birds which suggest in them the capacity for enjoying refined pleasure, which in man is attributed to an æsthetic sense, derived from the love of the beautiful, as revealed in music, motion, and colour. Whether, however, the mental origin of these vocal and picturesque displays is identical in the bird and in the human being is a question not essential to my present argument. The striking development of apparently æsthetic tastes in birds finds no counterpart in any other order of animals. It is the distinguishing mental feature of the Avian race; and, when our researches into the mental powers of animals become more advanced, we shall probably discover that other classes of animals also possess their own special mental characteristics, although of a kind less attractive to us.

Certain animals exhibit psychical peculiarities which indicate that elements exist in their minds not present in the human mind. The sense of direction, whereby many animals, after being transported to long distances, can find their way back to their homes by a direct route along untried paths, is one. A remarkable example of this power is recorded as having occurred in 1816. In that year an ass was embarked at Gibraltar for Malta, in the frigate "Ister." The vessel grounded upon some sandbanks near Cape Gata, in Spain, and the ass was thrown overboard to give it a chance of regaining land. This the animal succeeded in doing, and made its way in the course of a few days to a stable at Gibraltar which it had formerly occupied. In order to reach Gibraltar it had made a journey of over two hundred miles, through a mountainous and difficult country, intersected by numerous streams of water, and which it had never traversed before. It may safely be averred that no human being ignorant of the relative geographical positions of Cape Gata and Gibraltar, as the ass must necessarily have been, could have accomplished such a feat.

Some facts were elicited during a discussion upon the outlying islands south of New Zealand, which took place at a meeting of the Wellington Philosophical Society last Novem-

ber,* which are very much in point. Sir Walter Buller stated that, speaking generally, each of these islands, or groups of islands, has its own albatros, its own penguin, its own cormorant, and its own set of small petrels. These islands, or groups of islands, are, however, merely the nurseries for the albatroses and penguins, which spend about ten months of the year roaming about the ocean, but unerringly find their way back, year after year, to their old breeding-places, although those islands are but specks in the wide waste of waters. It may be urged of the albatros that it can mount in the air and take its bearings when looking for its island asylum; but this is beyond the penguin's powers to do. Owing to its conditions of existence, it is unable to leave the water, and, swimming on the surface, can, at the best, see only a few yards ahead. And yet, with unerring precision, each species of penguin flies straight back to its particular island sanctuary, and to its own community. There is no human faculty corresponding with the faculty whereby the penguin accomplishes so remarkable a feat. The old Maori navigators who found their way from Hawaiki to New Zealand without the aid of chart or compass, like the early navigators of other countries, followed the guidance afforded them by the sun and the stars; but we cannot imagine the penguin to possess even an elementary knowledge of astronomy. Indeed, it is not certain that it can even see the sun and the stars. Still, mysterious as the sense of direction is, we can comprehend its nature; but animals possess other mental powers which are less within our ken.

Experiments made by Lubbock show that good reason exists for believing that ants and daphnias are sensible to the ultra-violet rays of the spectrum, or the actinic rays, as they are sometimes called, to which human beings are insensitive. Earthworms, newts, and other low forms of animal life display a similar susceptibility to these rays. Whether this sensitiveness is an extension of the visual sense, or whether it arises from a distinct sense unknown to man, remains to be proved. Then, too, insects are evidently capable of hearing extremely shrill tones inaudible to a human being; on the other hand, deep and massive sounds, which strongly arouse man's feelings, are unheard by the insect. The possession of these novel senses, or the material variations in the visual and auditory senses of the animal from the corresponding senses in mankind, must cause the aspect of the outer world which is presented to the animal mind to differ materially from that which is presented to the human mind, and corresponding differences in the psychical development must result.

* Trans. N.Z. Inst., vol. xxviii., p. 738.

While the animal mind has grown and developed *pari passu* with the animal body, it apparently possesses no self-originating power. The animal is mentally the creature of external circumstances—formed and fashioned by the outer world. When the mind of any kind of animal is become perfectly fitted to meet the physical wants of the body and guard against its destruction by enemies it ceases to grow. The lion of the present day has reached no higher mental grade than the lion of the days of Julius Cæsar. It may be that the animal's habits, like its body, have become somewhat altered to suit altered surroundings—if the surroundings have changed—but the animal occupies the same mental level now as it did then. It is the same with our tamed and domesticated animals, which, notwithstanding their daily intercourse with man, have made no appreciable mental advance, although their dispositions have become milder, or, at least, they have learned to keep the native fierceness of their tempers under control. There is no valid reason for supposing that the modern racehorse is a more intelligent animal than the horses which were driven in chariot competitions at the Olympic games. The elephant is a sagacious animal; but, although man has tamed it, and employed it in the arts of both war and peace for thousands of years, its sagacity has not developed into any higher mental faculty. No domesticated animal, nor even monkeys bred in confinement, has ever yet learned to make a fire for itself. An animal's mental capacity is exactly measured by its place in creation, and it shows no power of raising itself into a higher mental plane by its own inherent vigour.

The human mind, on the contrary, possesses a self-originating power which enables it to overcome external circumstances. When I use the term "self-originating power" I do not refer to superior mental energy under another name. Many individual animals exhibit a mental energy superior to that of their fellows. The leaders of the herd attain that position by the superiority of their courage as well as that of their bodily strength over that of their rivals. By self-originating power I mean that special mental quality which has enabled man to invent civilizations and all the arts of war and peace. The human mind, unlike the animal's, is not merely the creature of the outer world—it possesses its own inner world also. A human being's mental capacity is not measured by his environment, nor by his bodily wants; he is gifted with faculties which transcend his daily needs, and are practically useless so far as the preservation and maintenance of his life are concerned. Nor could these faculties have been evolved by the pressure of surrounding circumstances. Wallace, in his work on "Darwinism," proves very clearly that the mathematical faculty, as exhibited in civilised man, could

not have been developed from the mental nature of the lower animals by variation and natural selection alone, and consequently some other influence, law, or agency is required to account for it. The mathematical faculty is not necessary to man's existence; he could live even in comfort without it; it is the spontaneous production of his own mind, and leads him into regions of thought altogether beyond his daily wants. Wallace puts the musical and artistic faculties in the same category with the mathematical, but I have just shown that in birds the musical faculty has attained a considerable development. Here, again, the distinction between the bird mind and the human mind is disclosed. Notwithstanding the exuberant delight which many kinds of birds take in singing, none of them has ever invented a musical instrument, or contrived any means of developing their voices; whereas man has created for himself musical systems, and devised a variety of instruments for producing combinations of harmonious sounds. The poetic faculty is likewise one which is peculiarly human, because, while some of the lower animals seem to possess the power of calling up mental images of past events, we have no just ground for concluding that any of them possess a mental power akin to the imagination which enables man to "body forth the forms of things unknown"; nor is it possible to understand how the pressure of outward circumstances in the struggle for actual existence could evolve such a power, since it would in no wise assist the animal in holding its own against competitors. It might, indeed, prove a disadvantage.

I regard this self-originating power which is possessed by the human mind as constituting the radical distinction between the human and the animal mind; and consider that, while the former has been evolved from the latter, as is proved by the numerous mental qualities which man and the lower animals possess in common, and, further, by the fact that we can make our wishes and feelings understood by many of the lower animals—and the more we study and learn to know them the wider become our capabilities in this respect—yet man has nevertheless been endowed with other mental faculties of a special character and of a different order to any appertaining to the brute. These faculties create an inner mental life in man; and the human mind of to-day is thus partly the hereditary creation of the outer world, and partly the outcome of the working of its own inherent forces, also modified by the influence of the experience of successive generations. I further believe that man, independently of his mental faculties, is gifted with a spiritual faculty, in which the animal does not share; but a consideration of this spiritual faculty does not fall within the scope of this present paper.

ART. V.—*A Phase of Hypnotism.*

By EDWARD TREGEAR.

[*Read before the Wellington Philosophical Society, 26th August, 1896.*]

WHILE lately trying to trace the relationship of words in the Pacific and Malayan Islands, I found one word of a peculiarly interesting character, interesting because beyond the boundaries of Polynesia proper it seemed to put on a veil of mystery. In one well-investigated Malay dialect it eluded translation, and in others the significations seemed to imply conditions for which the European has no equivalent in terms.

The word in question is the Polynesian *rata* or *lata*. It signifies in New Zealand "tame, quiet"; also "familiar, friendly." It enters into the composition of many of our place-names, such as that of Whangarata, "quiet beach." In Samoa it means "tame, domesticated; at home in a place; to be near"; *fa'a-lata* is "to cause to come near," and *fa'a-latalata* "a coquette." Another Samoan signification of *lata* is "my," the possessive pronoun. This is curious, because it has no affinity with other Polynesian pronouns. In the same dialect *la'u*, "my," is also used, this latter form being comparable with the Maori *taku*, "my," &c., and is on the regular formation of other Samoan pronouns, while *lata* is not. In Tahiti *rata* means "tame, docile, familiar"; *faa-rata* "to tame, to make a person or animal familiar." In Futuna *lata* is "tame, familiar"; and the corresponding word in Hawaii is used for domesticated animals, and for taming wild ones. One of the Hawaiian compound words—viz., *palaka*—means "to be inattentive; inefficient; to live without thought or care; to be dull or stupid; stupidity; hard-heartedness." In Mangareva, while the simple verb *rata* means "to do often" and "to be of good appearance," the causative, *aka-rata*, signifies "to pretend inspiration; to assume to be the mouthpiece of a deity; a prophet, a sorcerer; a man possessed of an evil spirit." These interpretations only confirm the immense value of the Mangarevan dialect as a treasure-hoard of old Maori, for in those Mangarevan Islands alone, almost the most easterly of the whole of the Pacific groups, do we find meanings similar to those to be discovered close up to the mainland of Asia, eight thousand miles to the westward. Be it noted also that the intermediate groups appear to know nothing of the hidden meaning of the word, for the conception of "tame, gentle, familiar" has nothing in it of

relationship (directly) to that of "under supernatural influence." Another puzzle: the Paumotuan Archipelago, of which the Mangarevan or Gambier Islands form a small part, is inhabited by natives who only know "tame, familiar" as the signification of *rata*.

Outside the area of the true Polynesian we find in Fiji a related word—viz., *lasa*, "to be easy; contented to be at home; tame." In the true Melanesian groups the word appears to be unknown or not recorded, with the exception perhaps of the Sinangolo dialect of New Guinea, in which *lata* means "milk." The reason for supposing a possible alliance is that the idea of tameness and of domestic animals might be further applied to the food obtained from animals that can be milked, such as the cow and goat. It is a very doubtful point, however, since it is probable that the inhabitants of New Guinea did not possess such domestic animals before the advent of Europeans. There is no proof that they did not. New Guinea was much too well known to voyagers from the Malay Archipelago and the Philippine Islands for the knowledge of domesticated animals to be entirely shut off. There is strong evidence for considering that cattle were known in former years as far east as Fiji, since the Fijians at once applied to the introduced animals the name by which buffaloes are known in the Malay Islands. It would seem much more probable that the word *lata* for "milk" was brought to New Guinea by the Spanish or Portuguese explorers, or by some people speaking a language derived from Latin, in which *lacta* means "milk." The Dutch would have called milk "*melk*," or some such word. It is not likely to have been the Spaniards, because their word for milk, "*leche*," would hardly have become *lata*; far more likely was the Portuguese "*leite*" to have been introduced along with the milk-producing creatures. At all events, this word can be set aside for the present as not requiring full consideration.

Invading the Malay district proper, we find in the Matu district of North Borneo that *rata* means "even, level," as it does in the true Malay of the mainland. But in the continental Malay we come for the first time in our journey upon a people who distinguish between the sound of *r* and *l*, and we find in Malay both *rata* and *lata*. To *rata* has been assigned the meaning "even, level," which agrees in substance with the Polynesian "tame, quiet, stupid." But in *lata*, or *latah*, we are met with a new and baffling sense to the word. Crawfurd, in his Malay dictionary, says that *lata* is "a peculiar morbid nervous excitability in women," and then gives a second *lata* as "to crawl or creep," marking the latter with *S* to show that it is of Sanscrit derivation. In Bima, a bay of the Island of Sumbawa, there dwells a people whose interesting speech has

been a source of delighted study to me for the last few months, for in Bima there seems to have been left behind among the Malays a belated colony of Polynesians as they moved eastward in the great migration. Mynheer J. C. J. Jonker, of Batavia, has lately published a Bima-Dutch dictionary, and in this work, under the head of *lata*, he writes as follows (I translate): "*Lata* is only used in the expression *batu lata ro batu nggende*, 'to follow without thought; to keep following as if begging,' and is used as the translation of the Arabic *taqlid*. In Makassar *lata* signifies 'to repeat one's words scornfully; to imitate.'" So far M. Jonker. I cannot discover in Makassarese precisely the meaning he gives, but it will be well to remember M. Jonker's information as to "repeating and imitating," and the Bima idea of following some one about, in the light of other references. In Bima the word as well as the sense is evidently obsolete, but we have the idea of a tame animal following like a dog, and also that it is applied to men as well as quadrupeds.

In Dr. R. F. Mathes's magnificent Makassar-Dutch dictionary he says that *lata* is applied to a person who starts at the slightest noise and begins to say and do all kinds of crazy things. This applies only to women. In the Bugis dialect (Celebes) the word has the same signification. *Lata-lata* is, Dr. Mathes tells us, "a certain nervous indisposition of women, who under its influence blab out everything that comes to their lips, and mimic everything that others do." He derives it from the Sanscrit *lata*, "childish." Sunda, the western portion of the Island of Java, has a very fine dictionary, prepared by Mr. Rigg. He says that in Sunda *lata* means "a person who is half-mad; often a woman who labours under aberration of mind, and has extraordinary fancies. It is known at Batavia and Bali. Gericke gives—to laugh without interruption, which is a sign of people who are *lata*."

Since, then, Dr. Mathes, in Makassar, and Mr. Crawfurd, in Malay, both refer the word *lata* to Sanscrit, it will be well to see what foundation there is for supposing the word to be continental, and, if of Sanscrit origin, allied to our own group of languages;* also, if it be Sanscrit, whether the original word showed any tendency of meaning towards "hysterical disorder." The greatest authority (in a dictionary sense) as regards Sanscrit is Professor Monier Williams. In his Sanscrit dictionary he gives us the meaning of *lata* as follows: "One who speaks like a child, a blockhead, a

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* The Sanscrit *lata*, "childish," which in Malay becomes "to creep, to crawl," and in Polynesian "tame, stupid," is probably represented in the Teutonic branch by *lat*, "slow, tardy." It is in Icelandic *lata*, "to be slow," and in English "late," &c.

fool; a fault, a defect. *Latya*, to speak foolishly." I think that this ends the matter so far as going north and west is concerned. The Sanscrit meaning appears to be a general term for any sort of foolish conduct, not for any particular sort, such as hysteria, &c., and the conclusion, therefore, appears to be that there is no radical sense of "hysteria" in *lata*, and that this is at once foreign and of later growth.

The matter would be hardly worth consideration if we could get no better light on the subject than the above remarks. Hysteria is not confined to the Malay Archipelago or mainland, and is of little interest except to specialists. Luckily, however, a book has recently been brought to my notice that puts a most interesting stock of knowledge in our hands. It is a book by the very distinguished Malay scholar Frank Athelstane Swettenham, C.M.G., British Resident-General of the Federated Malay States, and is entitled "Malay Sketches." Most of the sketches are written in a pleasant, readable manner, and pretend to no more scientific footing than that which must always be commanded by any words of one who shows intimate acquaintance with his subject. This is the reason why I dare to extract a chapter of his book—viz., the fear lest the book might be mistaken for an ordinary series of travelling notes and observations only worthy to wile away an idle hour, whereas they contain many points of deep interest to the student of ethnology, and in this case a particularly well-lighted picture of the sufferers by *lata*, showing at once that *lata* is a distinct mental affection, and that it is by no means either hysteria or peculiar to women only.

"In the spring of 1892 I was privileged, by the kindness of a friend and the courtesy of Dr. Luys, to visit the Hospital de la Charité in Paris, where I witnessed some very remarkable and interesting experiments in suggestion. There were patients undergoing successful treatment for nervous disorders, where the disease was in process of gradual relief by passing from the afflicted person to a medium without injury to the latter. There was the strange power of hypnotising, influencing, and awakening certain *sujets* whose nervous organizations seem to be specially susceptible; and there was the astonishing influence of the magnet over these same *sujets* when already hypnotised. There is something more than unusually uncanny in the sight of a person filled with an inexplicable and unnatural delight in the contemplation of the positive end of a magnet, and, when the negative end is suddenly turned towards him, to see him instantly fall down unconscious as though struck by lightning.

"The *sujets* (there were two of them, a man and a woman) described the appearance of the positive end of the magnet as producing a beautiful blue flame about a foot high, so

exquisite in colour and beauty that it transported them with delight. As to the negative end, they reluctantly explained, in hesitating words and with every appearance of dread, that there was also a flame, but a red one of fearful and sinister import.

"I was deeply interested in these 'manifestations,' both for their own strangeness and because I had in the Malay Peninsula seen equally extraordinary proceedings of a somewhat similar kind.

"Amongst Malays there is a well-known disease (I use the word for want of a better) called *látah;* it is far more common at certain places than others, and among certain divisions of the great Malay family. Thus, while there is generally one or more *orang latah* to be found in every kampong in Krian, where the Malays are mostly from Kedah, in other parts of Perak it is rare to ever meet a *látah* person. Again, speaking generally, the disease seems to be more common amongst the people of Amboina, in Netherlands India, than those of Java, Sumatra, or the Malay Peninsula. In both cases heredity is probably accountable for the result, whatever may have been the original cause to produce the affliction in certain places more than others. I can only speak of my own experience, and what I have personally seen, for no English authority appears to have studied the matter or attempted to either observe *látah* people, diagnose the disease (if it is one), search for its cause, or attempt to cure it. I can vouch for facts, but nothing more.

"In 1874 I was sent in H.M.S. 'Hart' to reside with the Sultan of Selangor. Though His Highness's personal record was one of which he might be proud, for he was said to have killed ninety-nine men (*sa' ratus kurang sátu*) with his own hand, his State was not altogether a happy one, for it had been the fighting-ground of several ambitious young Rajas for some years. An unusually hideous piracy, personally conducted by one of the Sultan's own sons, and committed on a Malacca training-vessel, had necessitated a visit from the China fleet, and when the perpetrators, or those who after due inquiry appeared to be the perpetrators, had been executed (the Sultan lending his own *kris* for the ceremony), I was sent to see that these 'boyish amusements,' as His Highness called them, were not repeated. The place where the Sultan then lived was hardly a desirable residence, even from a Malay point of view, and it has for years now been almost deserted. 'Bandar Termâsa,' as it was grandiloquently styled, was a collection of huts on a mud-flat enclosed between the Langat and Jugra Rivers. It was only seven miles from the sea, and at high tide most of the place was under water.

"With me there went twenty-five Malay police from Ma-

lacca, and we lived all together in an old stockade on the bank of the Langat River. Whether it was the mosquitos, which for numbers and venom could not be matched, or whether it was the evil reputation of the place for deeds of violence is needless to inquire, but the police were seized with panic, and had to be replaced by another batch from Singapore, selected not so much on account of their virtues as their so-called vices. The exchange was satisfactory, for whatever sins they committed they showed no signs of panic

"Later on I was encouraged by the statement that Bandar Termâsa, for all its unpromising appearance, was a place for *men*, where those who had a difference settled it promptly with the *kris*, and cowards who came there either found their courage or departed. A story that amused the gossips was that, as a badly-wounded man was carried from the duelling-field past the palisade which enclosed the Sultan's house, His Highness had asked, through the bars, what was the matter, and, being told, had laconically remarked, 'If he is wounded, doctor him; if he is dead, bury him.'

"During my residence in the place a lady, for jealousy, stabbed a man of considerable note thirteen times with his own dagger, and sent the next morning to know whether I would like to purchase it, as she did not much fancy the weapon. The man was not killed, and made no complaint. Another lady, for a similar reason, visited our stockade one night, pushed the sentry on one side, and, finding the man she wanted, attempted to stab him with a long *kris* she had brought for the purpose. That was then the state of society in Bandar Termâsa.

"I have said that we lived all together in a stockade. It was a very rude structure, with log walls about 6ft. thick and 8ft. high, a mud floor, a thatch roof, and no doors. Outside it was a high watch-tower of the same materials, but the ladder to it had fallen down. Of roads there were none, but a mud path ran through the stockade from river-bank to village, distant some 300 yards. My own accommodation was a cot borrowed from the 'Hart' and slung between two posts, while the men slept on the walls of the stockade.

"The place had drawbacks other than mosquitos, for the public path ran through it, the tide at high-water completely covered the floor, and the log walls were full of snakes. The state of the surroundings will best be understood when I say that during the many months I lived there I did not wear boots outside the stockade, because there was nothing to walk upon but deep mud, and that the only water fit to use was contained in a well or pond a quarter of a mile off, to which I walked every day to bathe.

"With the second batch of police had come a European

inspector, and he and I were the only white men in the country.

"Amongst the twenty-five police were two men of the name of Kâsim; they were both natives of Amboina, but very different in disposition, and they were known among their comrades as Kâsim *besar* and Kâsim *kechil*—that is, Kâsim major and Kâsim minor. Kâsim major was a quiet, reserved, silent man of about twenty-five, and I afterwards realised that he had a somewhat violent temper when roused. Kâsim minor, on the contrary, was a smiling, talkative, happy, and pleasant-looking young fellow of about twenty. They were not related to each other in any way.

"I used often to be away on the coast and up river, and on my return from one of these expeditions I noticed the men teasing Kâsim minor, and saw at once that he was *lâtah*. I questioned the inspector, and he told me that during my absence he had one day been away on duty for some hours, and when he returned, about 4 p.m., he saw Kâsim minor up a coco-nut tree just outside the stockade. On asking him what he was doing there, he replied that he could not come down because there was a snake at the bottom of the tree. In reality there was a bit of rattan tied round the tree, and, this being removed, Kâsim came down.

"Now, it is no easy matter to climb a coco-nut tree; it requires a special training to do it at all, and Kâsim did not possess it. But the inspector ascertained that the other police had found out by accident that their comrade was *lâtah*, that they had ordered him to climb the tree, which he had at once done, and that then, out of sheer devilry, some one had taken a bit of rattan, said, 'Do you see this snake? I will tie it round the tree, and then you can't come down'; and so left him from 10 a.m. till the afternoon, when the inspector returned and released him. The time of Kâsim's penance was probably greatly exaggerated, but that is how the story was told to me, and of all that follows I was an eye-witness. I made Kâsim minor my orderly, and, as he was constantly with me, I had better opportunities of studying his peculiarities. About this time also I learnt that Kâsim major was also *lâtah*.

"Speaking generally, it was only necessary for any one to attract the attention of either of these men by the simplest means—holding up a finger, calling them by name in a rather pointed way, touching them, or even, when close by, to look them hard in the face—and instantly they appeared to lose all control of themselves, and would do not only what they were told to do, but whatever was suggested by a sign.

"I have seen many *lâtah* people, male and female, but never any quite like these two—none so susceptible to outside influence, so ready to blindly obey a word or sign. The kindly

disposition of Kâsim minor made him quite harmless, but the other Kâsim was rather a dangerous subject to play tricks with, as I will presently explain.

"The *lâtah* man or woman usually met with, if suddenly startled by a touch, a noise, or the sight of something unexpected, will not only show all the signs of a very nervous person, but almost invariably will fire off a volley of expressions more or less obscene, having no reference at all to the circumstance which has suddenly aroused attention. As a rule, it is necessary to startle these people before they will say or do anything to show that they are differently constituted to their neighbours, and when they have betrayed themselves either by word or deed their instinct is to get away as quickly as possible. Children, and even grown-up people, cannot always resist the pleasure of 'baiting' a *lâtah* person, for one reason because it is so exceedingly easy, for another because they are inclined on the spur of the moment to do ludicrous things or say something they would under ordinary circumstances be ashamed of. Almost invariably *lâtah* persons of this class (and it is by far the most common one) are very good-humoured, and never seem to think of resenting the liberty taken with their infirmity. If by word or deed they commit themselves (and that is not uncommon), they either run away, or appear to be unconscious of having said or done anything unusual (this, however, is rare), or they simply say, 'I am *lâtah*,' as a full explanation and excuse. If any one present accidentally drops something on the floor, if a lizard falls from the roof on to or near a *latah* person, if the wind blows the shutter of a window to with a bang, a *lâtah* person of the class I speak of will probably find it necessary to at least say something not usually heard in polite society. Of this class by far the majority are women. I have never seen a *latah* boy or girl, but I know they are to be found, though the disease certainly becomes more evident as the subject grows older. It must be understood that, except when under influence, when actually showing the evidences of this strange peculiarity, *lâtah* people are undistinguishable from others. It is sufficient proof of this that amongst my twenty-five police there should have been two men more completely *lâtah* than any I have seen before or since.

"I took occasion to carefully observe the two Kâsims. It was impossible to always prevent their companions teasing them, especially in a place where there was absolutely no form of amusement, and all the conditions of life were as unpleasant as they well could be; but no harm was ever done, and I am satisfied that while influence was in any way exercised over the *lâtah* man he was not conscious of his own actions, and directly it was removed he became his reasoning other self,

and the utmost that remained on his mind or came to him with the recovery of his own will was that he might have done something foolish. If the attention of either of these men was arrested, as I have said, by word, sign, or a meaning glance, from that moment until the influence was removed the *latah* man would do whatever he was told or signed to do without hesitation, whether the act signified was difficult, dangerous, or painful. When once under this influence any one present could give the order and the *lâtah* man would instantly obey it; not only that, but even at some distance (as in the coco-tree incident) he appeared to be equally subject to the will imposed on his actions.

"A curious thing about both these men was that, having attracted the attention of either, if you said 'Kâsim, go and hit that man,' he would invariably repeat what was said word for word, including his own name, while he carried out the order. When the person hit turned on him, Kâsim would say, 'It was not I who hit you, but that man who ordered me.' I have seen Kâsim the younger, when the man influencing him put his own finger in his mouth and pretended to bite it, imitate the action, but really bite his finger hard. Similarly I have seen him, in imitation, and without a word being said, take a lighted brand from the fire, and he would have put it in his mouth if the experiment had been carried so far. Some one told him one day to jump into the river, and he did not get out again till he had swum nearly 200 yards, for the stream was both broad and deep, with a terrible current, and infested by crocodiles. If at any moment you called out '*Tolong!* Kâsim' (Help! Kâsim), the instant he heard it he would jump up, and, crying '*Tolong!* Kâsim,' dash straight to you over all obstacles. If then you had put a weapon in his hand and told him to slay any one within reach, I have not the slightest doubt he would have done it without hesitation.

"I have said there was a ladderless watch-tower outside the stockade. The police wanted firewood; they were not allowed to burn the logs forming our walls, but at the top of the watch-tower there were also log walls that they were told they could burn. They were lazy, however, and did not see how they were going to get up, so they ordered Kâsim the younger to climb up, which he did, as he had climbed the coco-nut tree, and when once there they told him to throw down logs until they thought they had enough. I watched that operation, and the feverish haste with which the man swarmed up one of the supports, gained the platform of the tower, and threw down huge logs as though his life depended on it was rather remarkable. I gave orders that the man's infirmity was not to be used for this purpose again, but in my absence I know that when more firewood was wanted Kâsim

went up to the watch-tower for it until that supply was exhausted.

"The path from the stockade to the village was in sight of the stockade throughout its length, and one day I noticed Kâsim minor, as he leisurely wandered down this mud embankment, stop every now and then and behave in a peculiar fashion, as though he were having conversation with the frogs, snakes, and other denizens of the ditches that bordered the path. When he had gone half-way he stopped and peeped up into the branches of a small tree on the roadside; then he seemed to be striking blows at an invisible enemy, ran to the ditch, and began throwing lump after lump of hard mud into the tree. I had not seen this phase of his peculiarities before, and could not make it out, but suddenly his arms went about his head like the sails of a windmill, and I realised that his enemies were bees or hornets, and that he was getting a good deal the worst of an unequal fight. I sent some of the men to fetch him back, and found he had been rather badly stung, and, when I asked him why he attacked the nest, he said his attention was caught by things flying out of the tree, and he was impelled to throw at them. I understood that the hornets flying out of the nest appeared to be thrown at him, and he could not help imitating what he saw in the best way he could, and so he took what was nearest his hand and sent it flying back.

"Kâsim the elder was quite as susceptible as his namesake, but his comrades were a little shy of provoking him, as they soon realised that his temper made the amusement dangerous. One day they must have been teasing him, and when he was allowed to recover his own will I suppose their laughter made it evident to him that he had made himself ridiculous, for he suddenly ran to the arm-rack, and, seizing a sword-bayonet, made for his tormentors with such evident intention to use it that they precipitately fled, and in a few seconds were making very good time across the swamp with Kâsim and the drawn sword far too close to be pleasant. I had some difficulty in persuading him to abandon his purpose, but after that, and a lecture, his comrades did not greatly bother him. I remember, however, that on another occasion we had secured and erected a long thin spar to serve as a flagstaff, but the halyard jammed, and it seemed necessary to lower the spar, when some one called out to Kâsim the elder to climb up it. Before I could interfere he had gone up two-thirds of the height, and he only came down reluctantly. Had he gone a few feet higher the pole would inevitably have snapped, and he would have had a severe fall.

"About this time a friend came and shared my loneliness for a fortnight. He had had experience of *látah* people before,

but the two Kâsims were rather a revelation, and he was, perhaps, inclined to doubt what I told him they could be made to do. One morning we were bathing as usual at the pond, and Kâsim the younger was in attendance carrying the towels, &c. The bath was over, and we were all three standing on the bank, when my friend said to Kâsim, '*Mari, kita terjun*' (come, let us jump in), at the same time feigning to jump Kâsim instantly jumped into the pond, disappeared, came up spluttering, and, having scrambled out, said, '*Itu tulak baik, Tuan*' (That is not good of you, sir). My friend said, 'Why, I did nothing; I only said, Let us jump in, and went like this,' repeating his previous action, when Kâsim immediately repeated his plunge, and we dragged him from the water looking like a retriever.

"When I was first ordered to Selangor I thought it possible that some sort of furniture might be useful, and I took up a few chairs and other things, including a large roll of what is known as Calcutta matting. The things were useless in a place where the mud floor was often under water twice during twenty-four hours, and they lay piled in a corner of the stockade, and whenever a Malay of distinction came to see me, for whom it was necessary to find a chair, it was advisable to see that the seat was not already occupied by a snake. The roll of matting, about 4ft. high and 2½ft. in diameter, naturally remained unopened. Every night, owing to the myriads of mosquitos, a large bonfire was lit in the middle of the stockade, for only in the smoke of that fire was it possible to eat one's dinner. One night some Malays from the village had come in, and the police were trying to amuse them and forget their own miseries by dancing and singing round the fire. Under such circumstances Malays have a happy knack of making the best of things; they laugh happily and often, and, as I have said elsewhere, they have a very strong sense of humour, if not always of a very refined description. Some one had introduced one of the Kâsims in his character of an *orang lâtah* for the benefit of the strangers, and one of the men was inspired to fetch the roll of matting, and, solemnly presenting it to Kâsim the younger, said, 'Kâsim, here is your wife.' Even now I do not forget the smile of beatitude and satisfaction with which Kâsim minor regarded that undesirable and figureless bargain. Breathing the words in a low voice, almost sighing to himself, 'Kâsim, here is your wife,' he embraced the matting with great fervour, constantly repeating 'My wife! my wife!' Some one said, 'Kiss her,' and he kissed her, repeatedly kissed her. Then, by another inspiration (I do not say from whence), some one brought up the other Kâsim, and, introducing him to the other side of the roll of matting, said also very quietly, 'Kâsim, this is *your*

wife,' and Kâsim the elder accepted the providential appearance of his greatly-desired spouse, and embraced her with not less fervour than his namesake and rival. It was evident that neither intended to give up the lady to the other, and, as each tried to monopolize her charms, a struggle began between them to obtain complete possession, during which the audience, almost frantic with delight, urged the actors in this drama to manifest their affection to the lady of their choice. In the midst of this clamour the Kâsims and their joint spouse fell down, and, as they nearly rolled into the fire, and seemed disinclined even then to abandon the lady, she was taken away and put back in her corner with the chairs and snakes. It is a detail, which I only add because some readers hunger for detail, that neither of the Kâsims possessed a wife.

"I do not pretend to offer any explanation of the cause of this state of mind which the Malays call *latah*. I imagine it is a nervous disease affecting the brain, but not the body. I have never met a medical man who has interested himself in the matter, and I cannot say if the disease, if it be one, is curable or not. I should doubt it. I have somewhere read that individuals similarly affected are found amongst the Canadian lumber-men."

Thus the long quotation. I have ventured to bring it before you in the hope that perhaps some information may be got on this side of the world. Since the word is so well known in one of its senses in the Pacific, there may be some knowledge of it as "hypnotism" yet to be gathered. How far did the priests of the South Sea temples or religions exercise the mesmeric power? It has been used by priests in all ages; but, so far, I have not been able to find direct mesmeric agency used in Oceania. It is most remarkable that in Mangareva we should find the word *rata* applied to a sorcerer, or one under the influence of a deity, which is always, among savages, a variety of madness or the imitation of it. What was this power that "tamed" persons, made them like domestic animals, or following as a dog follows, or crawling like a child? Surely it was some mental influence, some power of hypnosis, that could make men depart so much from their usual habits. Even the Samoan *fa'a-latalata* ("to act the coquette") seems to give a hint of nervous susceptibility, because it wars with the general sense of "tame, flat, level." In any case I trust that the unusual subject of this paper may excite some interest among students of mental phenomena.

ART. VI.—*Kerns and Serifs.*

By R. COUPLAND HARDING.

[*Read before the Wellington Philosophical Society, 23rd September, 1896.*]

STUDENTS of language have only of late years fully recognised the value of the rarer and more despised words of a language. Among the humbler forms, unknown in literature, but surviving in provincialisms, in slang, and in workmen's technical terms, may be found important key-words, opening up relationships otherwise untraceable. Therefore, to the philologist no word is common or unclean, and he has a just ground of complaint against those lexicographers—and they constitute the majority—who from prudery or fastidiousness as to classical forms pass over not only rare and special words, but many terms quite familiar to every ear in vulgar speech. Not only the student of language but the moralist has ground of complaint, for mock-modesty and pedantry of any kind never tend to elevate, but always to debase, the verbal currency

It is not my intention, however, to touch on any "risky" questions of language. I have to direct attention to two old and curious words in use by all English printers—words which have baffled all etymological research—and to offer some suggestions thereon. I know how dangerous is the ground, and that it savours of presumption to offer any theory upon words which have been the despair of etymologists, with all the equipment that scholarship can give. Therefore I will not be so unwise as to dogmatize, but will confine myself to suggesting what seems a possible and not improbable origin of each of the words in question.

While every trade and profession has its special lingo, unintelligible to the uninitiated, the printing trade is specially distinguished for the richness of its technical vocabulary. Several dictionaries and glossaries of the trade have been published, and I have all of any importance; but not one—not even the latest, the fine work published by the Howard Lockwood Company of Philadelphia in 1891-94—attempts to trace the derivation of the words; nor is one of them complete, numerous words in common use finding no place as yet in any collection.

Printers' argot may be divided into two well-defined sections: First, the ancient words, originated by workmen who were one and all classical scholars and members of a recognised liberal profession; secondly, the terms coined by the modern workmen—homely, often coarse, and mostly unmitigated slang. In the former class is that curious group of

ecclesiastical terms, showing the close association between the printers and the other foremost scholars of the fifteenth century—the clerical scribes—who were gradually superseded by the printing press. Thus we have in sizes of type, "brevier," "pica," and "canon"; in the office arrangements the "chapel," with its "father," and the "devil"; while the black smudges and grey patches in bad presswork are respectively "monks" and "friars." Even where there was no such allusion, we have in the word "quadrates" (shortened to "quads" by the modern workmen), applied to the large blanks used to fill out a line, a wholly different method of nomenclature from that which in late years has given us such forms as "bridging," "hammering," and "slating"—slang expressions well understood in the trade, wholly meaningless to an outsider, and which, so far, have never figured in any glossary.

The difficulty of tracing a technical term to its root was well illustrated lately by an interesting discussion as to the origin of the word "flong"—the name by which the moulding material in the *papier-mache* process of stereotyping is universally known. It is only about forty years since the process was invented, but the derivation of the word is uncertain. One ingenious writer, finding that "flong" was an old English form of the verb "fling," suggested this obsolete word as the original of the term, the mould being "flung" on the type, and beaten down (Swedish *flenga*) with a brush. But modern workmen do not hunt up forgotten Teutonic forms wherewith to coin technical terms. With greater probability another suggested the French *flan*, "a thin, soft cake or custard" (English form, "flawn"), to which the moulding material bears some resemblance. This theory met with wide acceptance, the process having been first followed in France. Another, and I think the correct, suggestion is simpler still, that "flong" is merely a corruption of the French *fluant*, "blotting-paper," of which the material is chiefly composed.

If so much doubt exists as to the origin of a term not fifty years old, one must be cautious indeed in speculating about terms which came into being when printing was not only an art, but a mystery.

First, I will briefly explain the words, for we must examine their meaning before we can hope to understand their origin.

"Kern" is a word from the type-foundry, but is as old as the period when every printer cast his own type. Ordinary letters stand square within the four corners of the type on which they are cast, are fully supported, and do not overhang. But certain letters, especially those cast on the slope, like scripts and italics, overhang the body and overlap each

other. An italic capital *F*, for example, followed by an *o*, overhangs the smaller letter. The overhanging portion is ingeniously bevelled off, affording the greatest possible support, and at the same time clearing the blank portion of the type following. If it actually rested on the next type, no matter how slightly, it would snap off under pressure. The small *f* overhangs both at head and foot. The *F* has a "kern" or is "kerned"; the *f* is "double-kerned."

The word "serif" is more easily illustrated than described. The ordinary roman capitals (THE) have serifs; the characters known to sign-painters as "block letters" (**THE**) do not possess them, and are called by printers "sans-serif," or without serifs, a form which would suggest a French origin were it not that in the fifteenth century "sans" was as good English as French. The etymology of the word is wholly unknown, and its uncertainty in this respect is emphasized by the fact that scarcely any two authorities spell it alike. I find it in all these forms, the first being the one adopted in the earliest printers' dictionaries: "ceriph," "cerif," "seriph," "serif," "seriff," "surryph," to which I may add the form adopted by Dr. Adam Clarke, the learned commentator, "seraph."

Any one so inclined may introduce a few more changes, but six recognised forms is a remarkable number. I know of no other English word with so elastic an orthography.

It is to Dr. Adam Clarke's note on the words "jot and tittle" (Matt., v., 18) that I am indebted for what I think is a clue to the real origin of the word. Our own word "tittle" does not assist us—it is merely a diminutive. It figures in all the seven historic versions, from Wicklif (1380) to the revised version of our own times; in the authorised version of 1611, as in the Geneva version, it was spelt with one "t," but Wicklif's spelling, "titil," clearly discriminates the word from "title." Curiously enough the identical word appears in Luther's German version, and in the Danish and Norwegian Bibles; in the Swedish, however, it is represented by another term, equally familiar to English eyes—"prick."

"Tittle," being Saxon, is a translation; "jot," on the other hand, is an untranslated Hebrew word in Greek dress, for the Hebrew names of the letters, though altogether foreign, were adopted in a very slightly modified form in Greek. Concerning "tittle," Clarke says: "One tittle or point, κεραια, either meaning those points which serve for vowels in this language, if they then existed, or the 'seraphs,' or points, of certain letters, such as ר *resh*, or ד *daleth*, ה *he*, or ח *cheth* (as the change of any of these into the other would make a most essential alteration in the sense, or, as the Rabbins say, destroy the world). Or our Lord may refer to the little ornaments

which certain letters assume on their tops, which cause them to appear like small branches. The following letters only can assume coronal apices: צ *tzaddi*, ג *gimel*, ז *zain*, נ *nun*, ט *teth*, ע *ayin*, ש *schin*. These, with the coronal apices, often appear in manuscripts."

It will be seen that the word *κεραια*, "tittle," according to Clarke's second and most probable suggestion, closely corresponds in meaning with "serif"; and, moreover, he uses "seraph" almost as if it were a Hebrew word, which it greatly resembles in structure. Dr. Clarke's knowledge of Hebrew and other Semitic tongues was extensive and minute, and he uses the word so ambiguously in the passage I have quoted that I am not now certain whether he got the word "seraph" from Hebrew or Arabic, or from his printer. Rabbi Van Staveren, who has kindly assisted me in this matter, knows of no such word; the one he gives me as corresponding most nearly to the English "serif" is סלוץ *cilook*. It is used to describe the slight projection distinguishing (for example) ד *daleth* from ר *resh*.

But, though the word means much the same, the importance of the thing signified is vastly different in the two alphabets. The serif in the Roman letter is little more than a superfluous ornament, like the "coronal apices" in Hebrew to which Clarke refers, and to which the scribes attached peculiar and mystical meanings. In monumental inscriptions it is dispensed with for the sake of simplicity. An I without serifs is represented by one line, H by three; with serifs three and seven lines respectively are required to complete the character. Where special legibility is sought, sign-painters and printers alike use letters without serifs. Far otherwise was it in Hebrew. Neglect of these minute details by a scribe might most grievously corrupt the text. Hence such sayings as these by the Rabbins: "Should any one, in Ps., cl., 6, change ה into ח he would ruin the world"; "Should any one, in Exodus, xxxiv., 14, change ר into ד he would ruin the world." In the one case the verb "praise," in the passage "Let everything that hath breath praise the Lord," would be turned into "profane"; in the other, "Thou shalt worship no other God" would become "Thou shalt not worship the only God." Examples like these, which could be multiplied, show the force of the passage that not one "tittle" of the law should be altered.

I think (always supposing that no Hebrew original can be found) that the Greek word rendered "tittle," *κεραια*, gives the key to the original idea. Κεραια signifies "a little horn." The resemblance of these projecting points to horns is quite sufficient to warrant this fanciful use of the word, which, probably, was not confined to the Greek. And though

"serif" does not resemble κεραια, yet, through the ambiguous use of our letter *c*, numerous Greek words beginning with κ are by us pronounced with an initial *s*, and "ceraia" certainly approximates to "ceriph."* Murray's great dictionary, now in course of publication, gives the only discoverable suggestion as to the etymology of serif. In 1868 a writer in *Notes and Queries* suggested the Dutch and Flemish *schreef*, "line, stroke," but the editor is doubtful, and says, "historical evidence is wanting." I think my etymology is at least as probable. At the same time, the singular variety of spelling seems to suggest transfer from some such language as the Hebrew, where exact transliteration is not possible.

I return to "kern." I find only two suggestions as to its origin. The Encyclopædic Dictionary says, "Perhaps from *crena*, "a notch." This I think exceedingly unlikely. A kern is not a notch, nor does it resemble one. All types have notches—a most important feature—but these are technically "nicks." Another, in a later dictionary, is attributed to Mr. Thomas MacKellar, a celebrated typefounder of Philadelphia, who thinks that the word may be derived from the Celtic *quern*, a hand-mill; but the connection of ideas is not obvious, nor does the word seem to have been one likely to have been adapted to this use by the early printers. Just as the serif is a "horn," so, I suggest, is the "kern." In one case the horn is a feature of the impressed character, in the other of the type which gives the impression.

The "serif," then, comes from the Greek κεραια; the "kern" from the Latin equivalent, *cornu;* and, if this be the case, two English words diverging as widely as the two I have been considering—"kern" and "serif"—spring from a common root. The vowel-change need give us no concern, for we find exactly the same in "corn" and "kernel."

I must add that my friend Sir James Hector has suggested another possible derivation of "kern," much more probable than *crena*, and deserving of consideration. He thinks it may be a form of "cornice," and the overhanging portion of the type might very fairly suggest the comparison. In this case we also go back to the Latin; but we find the root not in *cornu*, but in *corona*, "a crown," and the analogy to the Hebrew would be found not in Dr. Clarke's "seraphs," but in his "coronal apices," in which the ancient scribes displayed their skill.

And once again, to anticipate possible criticism, I repeat that I put forward these etymologies only as suggestions, to my mind more probable than any that have hitherto been made public.

* We have a good example from the same Greek root in the word "rhinoceros."

Art. VII.—*On Fires in Coal-ships: Their Causes and Prevention.*

By J. C. Firth.

[Read before the Auckland Institute, 6th July, 1896.]

Fires on coal-ships have become so frequent, and are attended every year with so great a destruction of property and so great a loss of life, that public attention is at last aroused to what is becoming a national calamity. Papers have been read on the causes of these fires before both learned societies and shipping associations; chambers of commerce have been appealed to; the Imperial Government set up a Royal Commission to inquire into and report upon them; and quite recently the English Board of Trade was appealed to on the matter. But, notwithstanding these efforts, no available means have yet been found for effectually dealing with fires in coal-ships, for their number is increasing year by year, and it is not too much to say that the word "failure" best represents to-day the position of the inquiries into both the causes of these fires and their prevention. So great has the pressure of these calamitous coal-cargo fires become at Newcastle, N.S.W., that it is almost impossible to insure a coal-cargo, and the cancelling of coal-charters is reported to be frequent at that port. It is not surprising, therefore, that the Government of New South Wales has set up a Royal Commission to report upon them, which is now sitting.

Now, under such circumstances, it will be readily believed that I should not have ventured to deal with this serious and important subject, but for the circumstance that for more than seven years my inquiries and investigations have been concentrated upon a somewhat kindred subject—the causes of fires on frozen-meat steamers, and their prevention. At the commencement of these investigations on the spontaneous combustion of charcoal I found myself in a very small minority, consisting of Sir James Hector, of New Zealand, F. C. Moore, Esq., president of the Continental Insurance Company of New York, Sir V. Majendie, H.M. Chief Inspector of Explosives, London, and a few eminent chemists. That very small minority has steadily increased, until it promises in no very long time to become a majority in the belief that fires on frozen-meat steamers are mainly caused by the spontaneous combustion of the charcoal with which they are insulated.

My pronounced success in these investigations has emboldened me to direct my attention to the causes of fires on

coal-ships, and their prevention. Naturally, in view of the inquiries made by so many able men, I hope it will be believed that I have approached the subject with great diffidence, and very much in the spirit of the mouse when it released the lion from the net—that is, of doing my little best to remove a very serious danger.

The grave importance of the subject will be further seen from the circumstances—(1.) That from the Port of Newcastle, New South Wales, alone, of twelve coal-laden ships which left that port from the 7th September, 1895, to the 18th February, 1896, nine ships were reported with their coal-cargoes on fire or heated. Nor is this heating of coal-cargoes confined to Newcastle coal, for Captain Andrew, of the ship "Crondale," reports that "on his recent voyage to San Francisco the temperature of his cargo rose to 103°, the cargo being from a southern New South Wales coal-mine." (2.) That in a letter from the Shipmasters' Society to the Board of Trade, dated the 10th February, 1896, it is stated "that twelve coal-laden vessels, representing about 20,000 tons, were abandoned at sea; seven vessels, of about 12,000 register tons, put into port in distress with cargoes shifted; and forty-six vessels, of about 70,000 register tons, were missing—unheard of—seven of the missing being steamers (period not named). The coal-cargoes of these missing and abandoned vessels are estimated at 130,000 to 140,000 tons, and the crews of the missing ships may be taken at about one thousand lost" (the latter drowned or burnt).

It must be understood that only a portion of these missing vessels were burnt, many of them having probably foundered at sea from the shifting of their cargoes, which is put down to imperfect trimming whilst being loaded.

Further on I shall treat of this question of bad stowage of coal-cargoes from imperfect trimming, but for the present I direct attention to the main subject of this inquiry—namely, causes of fires on coal-ships.

At this point it is necessary to describe the chief mode of putting coal on board ships at the great coal port of Newcastle, New South Wales, which may be taken as similar to the practice in most of the great coal ports in the United Kingdom.

The coal is brought by rail alongside the ships in trucks containing from 5 to 10 tons. The box portion of the truck is then lifted by a powerful steam-crane, swung over the hatchway, and the truck-load of coal is dropped bodily into the hold. As each truck-load follows the coal is very much broken and pulverised into small coal, slack, and dust. As this dumping down of the coal proceeds, a great cone of small coal and slack is formed, and pounded into a more or less hard

mass. Down the sides of this cone other truck-loads of coal are then dumped, and, rolling down, are stowed by trimmers in the vacant parts of the hold. When the main hatch is filled, the remaining hatchways are filled in like manner with a cone of small coal and slack, and the vacant spaces stowed by trimmers as before.

Causes of Fires.

As before stated, my long investigation into the causes of fires on charcoal-insulated frozen-meat ships has led me to the conclusion that these fires are caused by the spontaneous combustion of the charcoal (carbon), owing to the well-known fact that charcoal possesses the property of absorbing oxygen, and concentrating within its pores nine times its volume of oxygen. When this concentration of oxygen occurs to the extent of even one cubic inch of charcoal, spontaneous combustion is certain to follow.

Now, coal, which may be said to be mineral carbon or charcoal combined with various gases, possesses, but perhaps in a higher degree, the property of absorbing oxygen when the necessary conditions are presented to it. In this view I am supported by eminent European authorities, such as Lewes, Richters, and Fayol. In the normal state of large or round coal, in which state it comes from the mine, coal is not subject to spontaneous combustion, as it has been known to have been stowed in bins for long periods without showing any signs of spontaneous combustion.

But under the present mode of loading coal-vessels the normal condition of large or round coal is largely absent, by reason of the cones of small coal and slack formed under each hatchway being pounded into a more or less solid condition. That small coal or slack in heaps takes fire most people who have visited a coal-mine will have seen. Even the heaps of slack from the secondary non-bituminous coal of New Zealand, containing little or no pyrites or sulphur, constantly take fire from spontaneous combustion. In bituminous coals, such as the South Staffordshire and similar coals, slack is particularly liable to spontaneous combustion, due to the rapid oxidization (absorption of oxygen) that is set up when finely-divided coal is brought into contact with air. Formerly, cases of the firing of coal-cargoes (being smaller) were not so frequent as now, yet I may state that, of four coal-ships which left a northern English port in 1858 with cargoes of coal for Aden, three were burnt. But now, when coal-ships are very much larger than formerly, fires on coal-ships are increasing to an alarming extent, as may be seen from a very able paper on "Coal Explosions on Shipboard," by Mr. Richard Benyon, F.R.G.S., appearing in the *Nautical Magazine* for April, 1892,

in which he states that "where the cargo is under 500 tons, the number of carriers meeting with disaster is but one in four hundred. Cargoes between 500 and 1,000 tons show a percentage of 1¼ of fires and explosions. This increases to 3½ per cent. when the coal carried is between 1,000 and 1,500 tons, and 4½ per cent. for 1,500 to 2,000 tons, while above 2,000 tons the percentage of disasters to cargoes is no less than 9."

In order that a clear idea may be formed of what the burning of a coal-ship at sea means, I may cite some of the latest cases recorded, that of the burning of the "Republic."

Burning of the "Republic."

The "Republic" left Newcastle, N.S.W., on the 22nd January, 1896, with a crew of thirty-two hands. The early part of the trip was devoid of adventure, and the discovery of a small column of smoke, which filtered through the chinks of the fore hatch on the 10th April, was the first thing to startle the crew. The thermometer in the ventilating-pipes showed a rising temperature, and, while alarm was an element still absent from the minds of the crew, it was decided to open the hatch, and when the hatch was opened very little smoke escaped, and the pumps were prepared to dispose of what was deemed merely a small blaze. The men kept up the brave struggle, labouring steadily at the pumps night and day. The battle went on without incident until the 15th April, when the gaining flames began to show their power. The sounds of small explosions of gas went fore and aft through the hold all day long, and culminated at 7 o'clock in the evening in a terrific explosion. Hatches 1 and 2 were blown overboard, the decks started, and the great vessel strained from stem to stern. The night of the 15th was a terrible one, and the crew worked on in desperation trying to subdue the fire fiend. When morning dawned a vessel was seen within speaking distance, which proved to be the ship "Hollinwood," and Captain Kidd, who by a curious coincidence had been in trouble of a similar nature, readily agreed to stand by the "Republic." On the following morning the explosions were renewed, and forks of flame shot up through the ventilators. On the 18th a further series of explosions occurred, and on the 19th Captain Hughes decided to abandon the ship. The two lifeboats were at once got ready, but, as it had been blowing hard since the previous night, the heavy sea running made it impossible to save anything but what the men stood up in. The mates commanded the boats, Captain Hughes remaining on the "Republic" until the crew had been transferred to the "Hollinwood," when he secured the ship's papers and was taken on board the latter vessel. The transhipment was a

difficult operation, both boats becoming partly filled. In such a sea probably all hands would have been lost, and the "Republic" would have been posted as "missing" owing to bad stowage. The "Hollinwood" stood by the burning vessel all night, and at 8 30 p.m. her main and fore masts went over the side, the decks and standing rigging having been weakened by the fire and both rendered incapable of sustaining the strain put upon them. All through the night the fire burned with unrestrained fury, and when day broke Captains Hughes and Kidd decided that it was useless to remain longer, and the "Hollinwood" was accordingly squared away on her course for San Francisco.

Heating of the "Hollinwood's" Cargo.

Captain Kidd, of the "Hollinwood," had a somewhat similar experience, but managed to save the ship at the expense of the cargo The "Hollinwood," a steel four-masted ship, belonging to McVicar, Marshall, and Co., of Liverpool, sailed from Newcastle, New South Wales, on the 10th December, with a crew of thirty-three hands all told, and a cargo of 4,060 tons of Caledonian coal, consigned to J. D. Spreckels and Co., of San Francisco. "On the eleventh day out," said the captain, "the thermometer in the ventilating-tubes in the vicinity of No. 2 hatch registered 98°, and upon discovering that my cargo was on fire I determined to put into Lyttelton, New Zealand, which was then only two days' sail distant. Owing to contrary winds, however, five days were consumed in making the port, during which time, of course, I made every effort to keep the fire under control, and successfully. At the recommendation of the surveyors who inspected the vessel at Lyttelton, I discharged all but 1,400 tons of my cargo there. I was fortunate in reaching port when I did, for even while the work of discharging was being proceeded with the heat between decks ran up to 122°. Beyond scorching the paint in the hold, however, the ship sustained no damage, and in accordance with instructions I sailed for San Francisco on the 8th February."

The "Knight of St. Michael."

As supplementary to the burning of the "Republic" and the heating of the "Hollinwood's" coal-cargo, I quote the very able report of E. F. Pitman, Esq., Geologist to the Government of New South Wales (February, 1896), upon the heated coal-cargo of the ship "Knight of St. Michael." I quote this valuable report in full, because it appears to me to describe the causes of the spontaneous combustion of coal-cargoes in a fuller and more lucid manner than any. other document I have perused.

The report of the Government Geologist is as follows:—

"I have the honour to report that I have made two inspections, on the 25th and 27th instant, of the coal-cargo of the ship "Knight of St. Michael," and have to report as follows: Previous to my visit the cargo had been inspected several times by the marine surveyors, copies of whose reports are herewith. From these reports it will be seen that the ship left Newcastle on the 1st February with a cargo of 3,216 tons of Wallsend coal. On the 2nd February the master took temperature at intervals between 8 a.m. and noon, and found that in No. 2 hatch it rose from 96° to 104°. He therefore put into Sydney Harbour, and on the 4th February the cargo was surveyed, and the temperature in No. 2 hatch was found to be 105°. The surveyors thereupon recommended the discharge of 300 tons of coal from this hatch. On the 6th February the surveyors made a second inspection, after the 300 tons had been nearly discharged, and, finding the coal still much heated on the surface, they recommended the discharge of a further quantity of about 500 tons, or until the ceiling was left practically clear. The cargo was again inspected by the surveyors on the 11th, 12th, and 14th instant, and on the latter date they were of opinion that all the heated coal had been taken out, and that the remainder was fit to be carried on. On the 14th instant the captain reported that the temperature of the coal in No 3 hatch was rising. The surveyors confirmed this on the 17th, and also found a slight increase of temperature in the coal in No. 4 hatch. They therefore recommended that coal be shifted from hatches Nos. 3 and 4 into No. 2 until the heated coal was reached, and that the heated portion be then removed and sold. On the 21st they reported, after another inspection, that there were no signs of heating in the remainder of the cargo, and it was therefore assumed that the difficulty had been overcome. Subsequently, however, it was ascertained that the temperature was again rising in No. 2 hatch, and I was then requested to report upon the matter. At about 9.30 a.m. on the 25th instant I found a temperature of 84° Fahr. in the centre of the coal immediately underneath No. 2 hatch, while in the hold near the side of the vessel the temperature was only 77°. It was noticeable that the coal contained a large proportion of small and dust. At about 9.45 a.m. on the 27th February I found that the temperature had risen to 88° Fahr. in the centre of the coal under No. 2 hatch, while in the hold near the side of the vessel it was 76°. At the same hour the temperature of the coal in No. 3 hatch was 79°, and in No. 4 hatch it was 73°, while the shade temperature on deck was 69°. It is clear from the foregoing remarks that the temperature of portions of the

cargo is at the present time abnormally high, and there is reason for believing that, if left alone, it would continue to increase until spontaneous combustion ensued. Samples of the coal taken by me have been analysed by Mr. J. C. Mingaye in the departmental laboratory, with the following results: From No. 2 hatch: Hygroscopic moisture, No. 1, 2·65, No. 2, 2·81; volatile hydrocarbon, No. 1, 35·80, No. 2, 35·32; fixed carbon, No. 1, 55·30, No. 2, 54·47; ash, No. 1, 6·25, No. 2, 7·40; sulphur, No. 1, 0·535, No. 2, 0·453. From No. 4 hatch: Hygroscopic moisture, 2·45; volatile hydrocarbon, 37·55; fixed carbon, 52·30; ash, 7·70; sulphur, 0·508. It may be stated, therefore, that the cargo consists of semi-bituminous coal of good quality, but containing large proportion of dust and smalls. The coal was, I am informed, screened at the pit-mouth, and its present condition is, I presume, due to subsequent handling. From the investigation of eminent European authorities, such as Richters, Fayol, Lewes, and others, there can be little doubt—(1) that the principal cause of spontaneous combustion in coal is the absorption of oxygen by the coal, and (2) that the most favourable conditions for the self-heating of coal are a mixture of small pieces and dust, an elevated temperature, a large mass or volume of coal to act as a non-conducting covering, and a certain volume of air. These conditions are precisely those which exist in the 'Knight of St. Michael's' cargo. The cargo was, I understand, loaded during the abnormally hot weather which prevailed at the end of January, and it is probable, therefore, that it reached the hold with an initial temperature of from 120° to 150° Fahr. In loading from the trucks at Newcastle a considerable proportion of small and dust has been produced by the fall and by the process of trimming; by the filling-up of the hold the volume of coal necessary to form a non-conducting covering has been provided; while just about sufficient air has access to the hold to complete the necessary conditions. I am of opinion, therefore, that the heating of the cargo of the ship 'Knight of St. Michael' is due, firstly, to the fact that the coal contains a large proportion of 'small' and 'dust,' and, secondly, to its having been loaded during abnormally hot weather. The proportion of 'small' and 'dust' has no doubt been increased by the shifting operations which have taken place since the arrival of the ship in Port Jackson, and I am of opinion that considerable risk would be incurred if the 'Knight of St. Michael' were allowed to put to sea with her cargo in its present state.—Edward F. Pitman, Government Geologist."

I think it is open to doubt whether the hot weather in January caused the heating of the coal in the "Knight of St. Michael," as the temperature of the coal at the side

of the ship was only 77°, the real cause being the heating of the cones of small coal and slack under the hatchways.

Commenting on the above report, the *Morning Herald and Miners' Advocate*, Newcastle, New South Wales, says:—

"The case of the heated cargo of the ship 'Knight of St. Michael' continues to excite considerable interest in shipping and insurance circles in Sydney. There can be no doubt of the injurious effect upon the Newcastle coal trade caused by this occurrence, however northern colliery-proprietors and their representatives may endeavour to prove that more has been made of the affair than circumstances would justify, as, according to statements made to the *Newcastle Herald's* Sydney representative by merchants and others in the metropolis, some of them are doing. The fact that the surveyors judged it advisable that a third of the cargo should be discharged after the ship had been in Port Jackson for a month is taken to be a full indorsement of the decision of the captain to return to port. As one gentleman put it, Captain Dodd was not likely to have put back, when he had the knowledge that such a delay would cause his owners considerable monetary loss and additional expense for harbour charges and lying idle, if there had appeared to be any safety in proceeding on the voyage. On the other hand, it is said that, by continuing his trip, the captain would have, in face of the surveyors' reports, been endangering a magnificent vessel, valued at £20,000, as well as thirty lives, for the sake of a coal-cargo worth only £2,000. It is generally agreed by shipping and insurance people in Sydney that, in the interest of the trade of Newcastle, it is advisable that the coal-owners should take steps to secure a full investigation of the matter. Otherwise, it is believed the trade of Newcastle may suffer from alarmist reports, which in many instances may not have as much foundation as in the 'Knight of St. Michael' case."

CAUSES OF COMBUSTION.

The conclusions to be drawn from Mr. Pitman's able and exhaustive report are clear enough:—

1. That the cause of the spontaneous combustion of the coal on board the "Knight of St. Michael" was the absorption of oxygen by the small coal in the hatchways.

2. That the most favourable conditions for the self-heating of coal are a mixture of small coal, slack, and dust produced under each hatchway by the dumping down of the coal from the railway-trucks, and forming a cone under each hatchway, consisting mainly of coal pounded into small coal, slack, and dust, thus presenting the conditions necessary for spontaneous

combustion of the coal-cargoes, which followed as a matter of course, as in so many other coal-ships.

Professor Lewes has laid shippers of coal under very great obligations by his highly valuable papers "On the Spontaneous Combustion of Coal-cargoes," and "On Spontaneous Ignition and Explosion in Coal-bunkers," read before the Institution of Naval Architects and the United Service Institution. In these valuable papers Professor Lewes says, "Newly-won coal possesses great power to attract and absorb oxygen; that small coal, weight for weight, having more surface than large, is more liable than large coal to absorb oxygen and take fire; that, as a matter of fact, fires in coal-laden ships begin generally under the hatchways, where the process of pulverising goes on till the cargo is complete. Coal shipped in rainy weather incurs additional risk—moisture causes crumbling and the exposure of fresh surfaces. Badly-broken coal offers so many more points of atmospheric contact than does a block of the same mass. Thus a cubic foot has six superficial feet of surface; but, if a cubic foot of coal be subdivided into cubic inches, the amount of surface exposed to oxidization would be 10,368 square inches, and when pulverised into slack the power of absorbing oxygen becomes very largely increased. These multiplied surfaces again increase the heat proportionately. At over 100° Fahr. the heat increases very rapidly: at more than 130° Fahr. actual ignition is only a question of days."

Fires in Coal-bunkers.

Referring to the ignition of coal in bunkers, Professor Lewes says, "In the fast ocean-steamers it is now becoming an event of frequent occurrence for the contents of coal-bunkers to ignite spontaneously, and many a hand-to-hand struggle has been waged between decks without the passengers even suspecting the threatened danger."

Seeing that 100° to 115° Fahr. is a common temperature in stoke-holes, and up to 135° is frequently met with, and that I have myself seen the temperature of a stoke-hole in the tropics at 150° Fah., yet, practically nothing has been done to prevent boiler and engine-room heat from passing into coal-bunkers.

Professor Lewes suggests the construction of double bulkheads, with the iron plates 6in. apart, and arrangements made for the slow circulation of sea-water between them to keep down the temperature in bunkers. I agree with Captain Froud, R.N.R., "that structural and other difficulties stand in the way of the adoption of the Professor's suggestion." (See Captain Froud's admirable paper "On Heating of Ships and Cargoes," read the 20th November, 1891, before the

Shipmasters' Society, London, and to which I am much indebted.)

PUMICE INSULATION.

On the question of the prevention of heat passing from stoke-holes or boilers to the coal-bunkers, instead of Professor Lewes's suggestion of filling the double iron bulkheads with sea-water, or filling them with air, as Captain Froud suggests, I would propose their being filled with calcined pumice; this material, with its innumerable air-cells, being indestructible and incombustible, and being one of the best and safest non-conductors of heat hitherto discovered. Captain Froud's suggestion of filling the bulkheads with air is inadmissible, because air facilitates radiation and circulation, under the influence of which the interior of the bulkheads would be heated and the air become a conductor of heat, and of no value. It is only when air is confined in minute cells, as in pumice, that it is a first-class non-conductor of heat.

VENTILATION.

The ventilation of coal-cargoes by means of iron or wood tubes, if there are no cones of small coal and slack under the hatchways, I consider unnecessary, and if cones of coal be formed in the hold these tubes often do more harm than good. If no cones are formed, surface ventilation by the removal of the hatches occasionally in fine weather will secure all the ventilation necessary.

CAUSES OF EXPLOSIONS.

In a great many of the fires of coal-cargoes explosions of a severe and dangerous character often occur. It is an error to suppose that great quantities of this explosive gas (commonly known as "marsh-gas") is generated and thrown off by coal in what ought to be its normal condition in a ship's hold—namely, large and round coal. When in that condition, with a normal temperature of 75° Fahr., only harmless quantities of marsh-gas will be found in the hold. This dangerously explosive gas is produced by heat, as may be seen at any gasworks, where large quantities of large and round coal are kept in bulk for considerable periods without developing heat. But when this coal is thrown into heated gas-retorts large quantities of gas are at once thrown off. So it will be in a ship's hold; if the coal is mainly large and round little or no gas will be evolved, and if no heat-creators in the shape of cones of small coal and slack (which are practically gas-retorts) be allowed to be formed in the ships' holds. It is these heated cones which generate and throw off large quantities of marsh-gas, and which cones, I have no hesitation in

saying, are solely responsible for all the fires and the explosions which occur.

Shifting Cargoes.

The shifting of coal-cargoes at sea is doubtless responsible for some of the "missing" coal-ships, but the presumption is strong that many of them have been burnt by the spontaneous combustion of their cargoes, and no one left alive to tell the tale of misery and disaster. Coal-trimmers are, I think, often unjustly blamed. There are doubtless some cases of false trimming, and no wonder, considering the very small pay coal-trimmers receive for doing very disagreeable work.

If shifting-boards are used, and the coal-distributor hereinafter described be employed, and a fair wage be paid for trimming, the danger from shifting cargoes will be reduced to a minimum.

Prevention of Fires.

I now pass on to the consideration of the best and most available means for the prevention of fires on coal-ships.

I have endeavoured to demonstrate that fires in coal-ships are caused by the formation under each hatchway of cones of small coal, slack, and dust, into which so considerable a proportion of large and round coal is changed by the dumping of coal from trucks into the unprotected holds—and, I may add, in a less degree from shoots or baskets—and that these cones become heated and take fire from the spontaneous combustion of the oxygenized small coal and slack they contain.

This paper is already too long, and, as the appliances for preventing fires on coal-ships will shortly be put to a practical test, it is not necessary to occupy more of your time or to try your patience further than to say, generally, that I propose to fix in the ship's hold a coal-distributor at varying points, from which the coal slides off, and, in so doing, makes so small a quantity of small coal, slack, and dust, and the coal lying so loosely, that it is deprived of all liability to absorb oxygen in dangerous quantities, thus preventing spontaneous combustion and reducing the risk of fires in cargoes of coal so loaded to an inappreciable minimum.

The distributor not only prevents the formation of dangerous cones of coal under the hatchways—as by the present system of loading—but fills the spaces under the hatchways with large and round coal. The distributor will not dispense with coal-trimmers, but it will enable the trimmers to do their work properly, and will secure better and safer stowage, and much less danger of shifting, than under the present system.

In this way the coal is very much less broken, is distributed much more widely, and the hatchways are filled with

large and round coal, deprived of all power to absorb oxygen, develope heat, or generate gas; and, instead of the hatchways turning out, as now, hundreds of tons of small coal and slack, thus reducing the selling-value of the cargo, the spaces under the hatchways turn out at least a fair sample of the entire cargo, and enable the captain and owners to obtain a much better price for their coal.

By this means of loading coal, with its attendant freedom from all danger of spontaneous combustion or of gas explosions, the owners and charterers will be able to effect insurances on ships and cargoes at reasonable rates, in place, as at present, of their either not being able to insure at all or at rates beyond their power to pay. Most important of all, an enormous loss of life and property, by the burning at sea of coal-ships and their cargoes, will be prevented.

ART. VIII.—*Presidential Address.*

By W. T. L. TRAVERS, F.L.S.

[Delivered to the Wellington Philosophical Society, 8th July, 1886.]

IN accordance with the established custom of this society, that each of its newly-elected presidents should open the year's proceedings by delivering an address, I propose to bring under your notice this evening some of the special subjects that are now engaging the attention of scientific men in Europe and the United States.

ANTARCTIC EXPLORATION.

Amongst these none has excited a greater degree of general interest, since the initiation of the "Challenger" expedition, than the explorations about to be undertaken in the antarctic regions, most of the secrets of which have hitherto remained as in a sealed book. The south polar land, which lies entirely within the antarctic circle, may, for the purposes of practical discussion, be treated as occupying a space equal to the whole area between the 70th parallel and the south pole; and the enterprising men who are about to engage in the proposed explorations will, therefore, have to deal with an unknown region of enormous dimensions. The surrounding ocean, within the limits of the antarctic circle, is at all seasons of the year more or less encumbered with icebergs and pack-ice, whilst the apparent coast-line, for nearly the whole of its known extent, presents a perpendicular and unbroken

wall of glacier-ice, perpetually fed from the snows which fall on the land within it, and varying in height from 150ft. to 200ft. As you are no doubt aware, many navigators of note, including Cook, Wilkes, Briscoe, D'Urville, Bellingshausen, and Ross, made attempts, prior to the year 1844, to examine these regions, of whom Ross alone penetrated the ice-pack, and after the most arduous exertions succeeded in reaching a point within two or three degrees from the 80th parallel, from which he saw the great active volcano named by him Mount Erebus. From the point thus reached he ran eastward for about two hundred miles along a perpendicular ice-wall, and then returned in a diagonal line, from the neighbourhood of the 162nd meridian west of Greenwich, to a point on the 180th meridian where it intersects the 70th parallel Little has been added since Ross's voyages to our knowledge of the position or extent of the south polar land, but, although the accounts of the several voyages are in themselves of much interest as evidences of the indomitable energy of the navigators engaged on them, and as matters of geographical information, their value, from a scientific point of view, is small when compared with the many more important results which may be expected from the operations of those who are about to engage in the proposed expeditions In the hope of obtaining these higher results, all the scientific bodies in Europe and the United States have long concurred in urging the necessity of replacing, by active and skilled explorations, the practically total neglect into which the examination of the antarctic regions has fallen since the above-mentioned expeditions; for with the exception of the data brought home by Ross, and those more recently obtained by the "Challenger," little, if anything, has been done to increase our stock of knowledge in any department of science in connection with those regions which can bear satisfactory comparison with the wonderful results that have followed from work done within the arctic area. There is no doubt, however, that the difficulties experienced by the few who have since attempted to explore the antarctic seas, and the gloomy accounts which they, one and all, gave of long and wearisome working through the ice-pack, and of the apparently interminable and impenetrable wall of glacier-ice which barred all efforts at land-exploration, were well calculated to excite exaggerated ideas of the obstacles to success presented both by the sea and shore aspects of the area in question. But recent experiences have, to a considerable extent, modified these gloomy views, and the fact that Captain Larsen, of the Norwegian steamship "Jasen," was not only able, with comparatively little difficulty, to sail along the eastern coast of Graham's Land, and to ascertain its correct position for upwards of two hundred miles, but was also able

to land twice in positions from which, had he possessed the appliances ordinarily used in arctic explorations, he might have made excursions over the glaciers that he saw flowing amongst still active volcanos, sufficiently indicates that no greater difficulty will in all probability be found in penetrating inland than has usually been experienced in exploring many parts of the arctic land areas. It will be remembered, too, that the Swedish whale-ship "Antarctic" recently visited the coast of Victoria Land in search of whales, following Ross's track to the vicinity of Mount Erebus, thus successfully fighting its way through the ice-pack to the ice-free sea of Ross. From thence she returned to the northward; and it is important to note that the return voyage through the pack-ice, made, it is true, in the latter part of summer, occupied only six days, as against the thirty-eight days which were required for the southward course in the earlier part of the season, the pack during her return through it having been found to be loose and easily penetrated. It was in this ship that Mr. Borchgrevink (a Swedish naturalist) obtained a passage under circumstances which have appeared, in some detail, in the Victorian newspapers, and he has told us that no difficulty was found in landing, first on Possession Island, on which Ross had raised the British flag upwards of fifty years before, and next at Cape Adare, on the mainland. Those who have read Mr. Borchgrevink's narrative of this adventure will remember his expressions of delight at having gathered a lichen, which he assumed to have been the first specimen of terrestrial vegetable life that had ever been discovered on the antarctic continent, and those of his regret at his having been unable to extend his researches, owing to the fact that the ship was engaged in a commercial adventure only.

These later accounts have led practical navigators and explorers to conclude that, with such bases of operation as are afforded by the eastern colonies of Australia and by New Zealand, those who are enterprising enough to engage in the arduous work of antarctic exploration will be able, as successfully as our great arctic explorers have done, to overcome all obstacles, and to hope that their labours will be accomplished without having to deplore any serious loss of life.

But it is not merely in the domain of ordinary geographical knowledge that the world would gain by persistent and scientific explorations of these regions. The wonderful results obtained by the "Challenger" staff have demonstrated how much may be done to extend our knowledge in many important branches of science by well-conducted researches even in regions which lie within the limits of ordinary traffic and observation. How much more, then, may be expected from

similarly-conducted explorations of practically new fields of inquiry, not only in the special departments of science which came within the scope of the "Challenger" expedition, but also in others of equal if not of greater practical importance. It is well known that the solution of some of the most intricate problems in various branches of scientific inquiry is at present impossible, in the absence of data that can only be obtained by means of successful observations in circum-polar regions, and more especially within the antarctic area. Many of these problems have lately been discussed in papers submitted to the greater scientific societies in England. For example, we are told on the highest authority that it is hopeless to strive with any prospect of success at the advancement of the theory of the earth's magnetism in the complete absence of data from the Southern Hemisphere beyond the 40th parallel. Those afforded by the magnetic survey made by Sir James Ross are no longer of any use for that purpose, for it is well known that such changes have taken place, since his time, in the magnetic elements south of that parallel that nothing less than a new and complete survey can supply the materials for properly revising the current theory of the revolution of the magnetic poles. The knowledge thus desired is of the greatest importance for the practical requirements of navigation. Magnetic maps, based on numerous direct observations, were calculated and drawn by Gauss upwards of fifty years ago, and some of the most eminent investigators in this branch of scientific inquiry have, ever since his time, been engaged in attempts at reconstructing them so as to make them available for the whole globe; but all their efforts to do so have been obstructed by the one insuperable obstacle—namely, want of knowledge of the necessary elements within an area of not less than three thousand five hundred miles in every direction from the south pole, a want which cannot be supplied by any amount of mathematical speculation. It is true that the *Bureau des Longitudes* of France is at present engaged in the construction of new magnetic maps, but it does not appear that their labours have as yet extended far, or proved very successful. It would seem that, in order to obtain a satisfactory general magnetic map, observations should be made over all regions as nearly as possible at the same time, and for this purpose observatories, with a competent staff and a supply of similar instruments for each, would be required at a considerable number of places. With such aids it will be possible to make practically simultaneous observations, and it may be hoped that all the great maritime nations will unite in a general effort to obtain them. Six of the expeditions appointed by the Bureau have already started to their appointed stations,

but I cannot find that any of these is charged with this duty within high southern latitudes. Great results are, however, expected by the Bureau from their present effort, and the maritime world is to be congratulated upon the important initiative thus taken up by the French Government.

A similar difficulty exists as regards modern investigations into the shape of our globe. It will be in your recollection that, during the last year's proceedings of this society, General Schaw read a paper pointing out that these investigations, like those last alluded to, are completely blocked for want of data from the Southern Hemisphere. Hitherto we have been content to look upon the earth as having the form of a ball, flattened at the poles, and to treat this flattening as following regular meridional curves, extending north and south from every point on the equator. It has, however, been demonstrated that this is by no means a correct view, but rather that our globe presents considerable irregularities of shape, both local and general, especially towards the poles, and that pendulum swingings made at various places in polar regions are absolutely necessary before reliable measurements of the earth's diameters can be made, correct diameter measurements being, in effect, the necessary bases of all measurements in astronomy. Pendulum swingings are now the recognised means for determining the extent of local deviations from the ideal form above alluded to, and very precise methods have lately been elaborated for utilising such swingings, which are found to afford rapid and exact means for the purpose in view. It is stated that not more than seven pendulum swingings have yet been made beyond the 50th parallel of south latitude, none of which were made within the antarctic circle, and hitherto all efforts at determining the exact shape of the earth have failed for want of them.

In 1867 the late Mr. Proctor drew attention to the permanent low barometer of the south temperate zone, and pointed out, in part explanation, that the centre of gravity for the solid portions of the earth lay somewhat to the south of the centre of figure. He stated that this explanation had long been received as accounting for two remarkable geographical features,—namely, the prevalence of water over the Southern Hemisphere, and the configuration of nearly all the peninsulas over the whole globe. He stated, moreover, that, in his view of its causes, it was immaterial whether or not those portions of the antarctic regions which had not then been explored were occupied chiefly by land, or whether the unexplored north polar regions were or were not chiefly occupied by a north polar ocean. But, although the existence of the low barometer in the temperate parts of the Southern Hemisphere has been long known, no generally-received explanation of its

cause has been put forward. We may hope, however, that this problem will also be solved as one of the results of the proposed expeditions.

It is also well known that the crust of the earth is not perfectly rigid, and pendulum swingings taken from time to time will aid in determining whether, if at all, the great masses of ice resting on the outer limits of the antarctic land, either with or without the accumulations of drift resulting from glacial erosion and deposited along the true shoreline, have caused subsidence of the areas on which they rest. Geologists are at present divided in opinion on this question, for the determination of which even a limited number of pendulum experiments made in Graham and Victoria Lands will be of more value than almost any amount of observation elsewhere.

Besides these matters, there is a probability, and, at all events, much expectation, that the proposed investigations will throw light upon important points relating to the origin and distribution of animals and plants in Tertiary times. It is abundantly clear that such questions cannot be fully solved whilst we remain in ignorance of the physical conditions, past and present, of the antarctic continent. In papers which I read before this society in 1877, I pointed out that, until the surface of our globe had cooled down to such an extent as to admit of water resting upon it at a temperature not inconsistent with life, no life in any of the forms known to us could have arisen at all. I also pointed out that astronomers and physicists were agreed that long before such a degree of cooling had taken place the earth must have revolved round the sun in its present orbit; and I further pointed out that, for long after any part of its polar surfaces had cooled down to the extent required for the existence and maintenance of life, the surface heat must have remained too great in equatorial regions to admit of this. If these views be correct, then it must be assumed that the polar regions were the first to present the necessary conditions for the development and maintenance of living organisms, and that these, and their modified forms, must gradually have spread towards the equator when and as the intervening surfaces became suited by temperature and otherwise to receive them. I still hold the same views, and the more strongly because, since I wrote the papers referred to, much greater authorities than I can pretend to be upon such questions have expressed similar ones. Whether, however, they have any foundation or not, it is certain, looking to the enormous extent and peculiar form of the antarctic continent, that we may reasonably look forward to some light being thrown upon the nature of the fauna and flora that occupied it during past times, by the

researches which will doubtless be shortly attempted in this direction.

There appears also to be ground for supposing that the greater portion of the interior of the antarctic continent will be found to be free from snow, at all events during the summer, or, in other words, that the area of precipitation of the snow which gives rise to the coastal ice cannot extend very far inland. There are, unquestionably, meteorological grounds for this assumption, which, however, can only be verified or disproved by actual exploration.

In connection with this branch of my address, I may be permitted to quote the following passages from a paper written by that veteran in the advocacy of north polar explorations, Mr. Clements Markham, in the year 1885, which may, with equal appropriateness, be used with reference to the proposed expeditions to the south polar regions:—

"Voyages of discovery have been, since the dawn of modern times, one of the chief causes of England's power and greatness. The material wealth which they have been the means of pouring into her lap is incalculable. For this alone they will ever be a leading feature in the history of a mighty commercial nation; for this alone they have been fitted out by many a merchant adventurer; and for this they have been incessantly urged upon the attention of many successive Governments. But it is not on account of the commercial advantages that have been derived from the labours of the explorer that those labours are to be most prized, seeing that it is not to wealth alone that England owes her greatness. Exploring adventures by sea and land have done as much to increase the store of knowledge as any other kind of research. They have led the way to the creation of that colonial empire which has spread the Anglo-Saxon dominion far and wide over the earth They have fostered the spirit of enterprise, and formed the nursery for the best of our seamen. They have been a school for our best officers, educating them in that calm self-reliance which the presence of danger alone can give. They have been most important agents of civilisation, creating a brotherly feeling of sympathy between the nations in time of peace, and giving one bright side even to the horrors of war, for, by the courtesy of international law, a scientific expedition is respected by all civilised nations. Let it once be known that an expedition of discovery will add to the sum of human knowledge, that it will lead to valuable scientific results, and that there is no chance of the men who compose it being overtaken by a catastrophe such as that which befel Sir John Franklin's people, and it ought to receive cordial support from public opinion. All men may not fully appreciate the value of

scientific researches, but no true Englishman can underestimate the importance of fostering the spirit of enterprise in his countrymen, or fail to desire that the race of men, from Cabot to McClintock, which has been formed by expeditions of discovery should be continued."

The noble views thus expressed lead me to suggest a hope that, when an adequate conception of the many advantages that must accrue to the world at large from the aid which properly-equipped antarctic expeditions may be expected to afford in solving the problems I have alluded to has been brought home to the Governments and people of the Australasian Colonies, they will extend to the enterprising men who are about to engage in those expeditions the like countenance, sympathy, and material assistance which are certain to be afforded to them, sooner or later, by the Government and people of our Mother-country.

Discovery of the Röntgen Rays.

Passing from the foregoing subject, I propose now to refer to a most remarkable event in the history of physical and chemical science that has lately occurred, and has excited extraordinary and universal interest. I allude to the discovery, by Professor Rontgen of Berlin, of the peculiar properties possessed by certain electric rays, associated with the well-known kathode rays, to which he has given the specific name of "X rays." On looking into the circumstances which led to this discovery, we find that in 1893 an account was published describing the researches in electro-magnetism made by the late Professor Hertz, of Berlin, with a view to an experimental demonstration of electro-magnetic waves. These researches formed the subject of an address read by Lord Kelvin at the opening of the winter session of the Royal Society early in 1894, in which he sketched the new horizons that were being opened out by experimenters in England and elsewhere in their further researches on the lines indicated by Hertz, and pointed out that in the results of these further researches lay his hope of obtaining additional knowledge of the relations between what is termed the ether of space and ponderable matter, and the part played by each in the transmission of electrical energy. Since the publication of Hertz's work it is no longer contended that electric waves can, any more than any other form of energy, pass through space without affecting the intervening medium; and, although it has not yet been demonstrated what form of strain would be produced upon the ether by these waves, it is conjectured that its molecules, if, indeed, the ether consists of molecules, are set into vibration across their line of propagation. Amongst the instruments used by Hertz in connection with these investiga-

tions were the vacuum tubes invented by Geissler. These tubes were made of glass, the two ends presenting dilatations into which platinum wires were fused, the tubes being closed when as much as was then possible of the atmospheric air within them had been exhausted. When the wires of one of these tubes were then connected with the poles of an induction apparatus a beautiful stream of light traversed its interior, the colour of which varied with the nature of the contents of the tube; and many of you have, no doubt, seen the exquisite luminous effects resulting from the passage of an electrical discharge from one wire to the other in such a tube. In this connection, too, I have to mention that there are numbers of fluid and solid bodies which become self-luminous under the influence of particular rays of light shown in the spectrum, a peculiarity first noticed in a form of spar called fluor-spar or calcium-fluoride, from whence the phenomenon has been named fluorescence; and it has been found that this property is exhibited by reason of the fluor-spar absorbing a portion of the light-rays directed upon it. But the only rays which produce this effect are the violet and ultra-violet rays of the spectrum, the latter of which are wholly invisible to the human eye except when passed through a glass or quartz prism, and when the bright part of the spectrum has been carefully shut off. But their existence at once becomes apparent when, as already noted, they are projected upon some fluorescent body. Experiment, moreover, has shown that the highly-refrangible rays which possess in the greatest degree the power of exciting fluorescence are contained in large proportion in the light emitted by a Geissler tube containing rarified nitrogen—a point to be specially noted in connection with the experiments made by Röntgen to which I am about to allude, and with the recent discovery of the gas named argon, to which I intend to call your attention further on. The means thus placed at the disposal of experimenters, and the study of the phenomenon produced by the use of them, soon opened up a wide range of discovery in the region of electrical science. Mr. Cromwell Fleetwood Varley, so long ago as 1871, pointed out that the luminous cloud which appeared in a Geissler tube as soon as the current had attained a certain intensity was composed of attenuated particles of matter projected from the negative pole in all directions, and he showed that an electro-magnet acted upon such a stream, gathering it into an arch and attracting it. He found also that the stream thus formed was intercepted when he placed a thin plate of talc in its way, and that, whilst a luminous cloud was formed on the side of the plate bombarded by it, what he described as a "shadow," but which really was a space pro-

tected from the bombardment, was apparent behind it. The material character of the electrical discharge, and the actual transport of matter by electricity, were thus demonstrated by Varley, but his experiments and their results remained for many years quite unnoticed.

Eventually, however, the matter was taken up by Crookes. After studying the mechanical work of light rendered evident by the radiometer, he devoted his attention to the phenomena indicated by Varley, and, utilising the enormous progress in mechanical science which had taken place since the latter had made his experiments, he obtained such an exhaustion of the Geissler tube as to leave in it only a few millionth parts of the air which it had originally contained. With this more perfect instrument of research he soon accumulated a vast array of important facts. He demonstrated that the electrical excitation of the negative terminal of the tube produced a molecular disturbance which affected the surface of the terminal, and that on this disturbance being communicated to the rarified gas in the tube a real torrent of material particles, which he treated as molecules of the residuary gas within the tube, rebounded from the surface of the negative pole in a direction normal to that surface. He also determined the velocity with which these molecules moved, which, of course, varied with the intensity of the current, and found that they did so at a speed varying from one to two miles in a second. But the most interesting observation which he made was that the torrent was composed of particles so material in character that a magnet exercised a powerful effect upon them, curving their trajectories in the same manner as gravitation acts upon a bullet fired from a gun. He also noted that the phosphorescent glow of the tube did not emanate from the particles themselves, but was produced by their impact upon the surface of the glass, to which they evidently imparted sufficient energy not only to render it luminous, but also to raise its temperature. From these effects he justly concluded that the particles thrown off from the negative pole and striking the glass were truly material. These experiments have been repeated and verified by a large number of observers in the first rank of electrical science, who have also come to the conclusion that particles of matter are projected by electricity at great speed from the negative terminal of a vacuum tube, and that this effect, coupled with their behaviour towards the magnet, and their sensitiveness to the approach of any conductor, affords a positive demonstration that the component particles of gas in the tube had been electrified by the discharge. In these remarks I have advisedly used the word "particle" in connection with the stream projected from the negative pole of the vacuum tube. Unfortunately, confusion

is often created by the indiscriminate use of the terms "atom" and "molecule." The word "atom" is properly applicable only to matter in its ultimate condition of divisibility, and the word "molecule" to a particle of matter formed by the chemical combination of two or more atoms. The number of possible combinations is practically infinite, and I have long thought that the lines in the spectrum indicate the more or less complex nature of such combinations, in the case of each of the substances experimented upon, those which give the fewest lines being less complex in molecular structure than those which present many lines. Professor J. J. Thomson, in a paper published in the *Philosophical Magazine* in October, 1893, points out that the electrification of a gas is not a mere mechanical process. In his view it is a chemical or quasi-chemical one, which goes on within its molecules. He conceives that part at least of the materials must be split up into atoms before electricity can be carried, for he shows that new combinations are formed when the dissociated atoms part with electricity. He maintains that a molecule of a gas, *quâ* molecule, cannot be electrified.

Two important questions at once arose from these demonstrations,—namely, What is an electrified particle? What progress is being made in physical research when we find that electrified particles are substituted, by electrical excitation, for the body of which they had been the component parts? These questions have not yet been wholly solved, but Crookes's experiments show clearly enough that the medium for the transmission of electricity must consist of ponderable matter in some form or other. Lord Kelvin, in commenting on these experiments and demonstrations, remarks that they had led him to the conclusion that the molecule contains both what are called ether and ponderable matter; though, as already observed, I think it much more probable that the supposed ether is neither more nor less than the ultimate form of matter, and that the molecule of any of the so-called simple bodies of chemistry is composed of atoms of some one homogeneous substance in a special condition of combination.

It was whilst engaged in similar researches, following the lines of discovery propounded by Hertz, that Röntgen noticed the peculiar nature and some of the properties of the dark radiations to which he gave the name of X rays. Now, when we speak of these rays as "dark radiations," we are using the term "dark" merely with reference to the limited visual capacity of the human eye, which, as is well known, can only perceive light-waves that are not shorter than $\frac{1}{38000}$ of an inch and not longer than twice that length, and it is by reason of this limitation in the capacity of the human eye that the ultra-violet rays at the violet end of the spectrum

make no sensible impression upon the retina. It is more than probable that in this we differ from many of the lower animals, especially amongst those which roam by night; but upon this point I do not pretend to be in a position to offer more than the suggestion. These ultra-violet rays, however, are those which most strongly, if not exclusively, affect the sensitive photographic plate, and therefore photography by means of that peculiar anomaly invisible light—viewing its effect from the standpoint of human vision only—is no new thing. What is entirely new in the X rays, and the points in which they differ completely from the Hertz electric waves (which, as already shown, possess all the properties of, and are capable of being reflected, broken, and polarised in the same way as, ordinary light) are that they have an incomparably smaller speed, are with difficulty reflected, are incapable of being refracted or polarised, and otherwise differ in so many respects from the latter as altogether to upset the current ideas about light. It has, indeed, been suggested that they belong to the borderland between light and electricity discovered by Hertz, and only those who have watched the progress of the researches made by experimenters following the suggestions of Hertz, and especially those made by Professor Lenard, could possibly have foreseen the existence of radiations having such singular properties.

Shortly before Hertz's death he noticed that, when the streams of apparently luminous matter already alluded to were projected against a thin plate of matter opaque to ordinary light, the light produced appeared to pass through it. For the purposes of his experiments in the same direction Professor Lenard transferred the kathode rays from the tube in which they were generated into another tube where he could use them in a variety of ways. This transfer was effected through a window composed of leaf aluminium, which would have completely intercepted rays of ordinary light, but through which the kathode rays passed at once into the next tube, a strong smell of ozone being developed during their passage. He afterwards found that a large proportion of the rays which passed through the window were invisible, for when the whole were thrown upon a paper screen covered with fluorescent matter this matter began to glow precisely as it would have done under an ordinary beam of sunlight or of electric arc light; but his experiments showed also that in many other respects their behaviour was quite different from that of ordinary light. To ascertain the nature of this difference he passed them through a variety of gases, liquids, and solids, his operations being thus summarised by a writer from whose work I have derived much assistance in preparing this part of my address:—

"When Lenard made the kathode rays pass through different gases, liquids, and solids their behaviour proved quite different from that of ordinary light. Various substances are, we all know, not equally transparent to sunlight, but their different degrees of transparency depend upon their inner structure or their chemical composition, not upon their density. Glass has a greater density than paper, but it is transparent to ordinary light, while paper is not."

"With the kathode rays it was quite the reverse. Paper was more transparent to them than glass, and aluminium, which is slightly less dense than mica, was more transparent than mica; as to the denser metals, such as gold and silver, they were quite opaque for the kathode rays even in very thin leaves. The same was noticed with all gases: their transparency, too, depended entirely upon their density. At the ordinary atmospheric pressure the kathode rays ceased to act upon the phosphorescent paper at a distance of a little over 2in., but in rarefied air they travelled a distance of 6ft. without being absorbed; and when Lenard experimented upon gases of different densities, such as oxygen and hydrogen, he found that it was sufficient to rarify oxygen to one-sixteenth part of its usual density to render the two gases equally transparent."

"In short, the absorption of the kathode rays proved to be in direct proportion to the density of the medium which they passed through. 'Like inertia and gravity,' Lenard wrote in December, 1895, 'the kathode rays depend in their absorption upon the mass of the matter they traverse. They do not behave like light, but like a cannon-ball, which is arrested in its course by the density of the heap of earth which it has to pierce.' Moreover, while usual luminous vibrations would take no heed of a magnet placed near their path, the kathode rays explored by Lenard were deflected by a magnet from their ordinary rectilinear directions. And yet—such is, at least, Lenard's opinion—the magnet acted not upon the rays themselves, but upon the medium they passed through; and what seemed still more incomprehensible was that the action of the magnet depended upon the way in which the kathode rays were generated—the more the air was rarefied in the vacuum tube where they took origin the greater was the magnetic deflection."

"At every step the physicist thus met with some new problem which he could by no means explain under the now current theory of luminous radiations. And finally, as if it were to establish one more affinity between these extraordinary rays and common light, Lenard discovered that when a photographic plate was brought near to the aluminium 'window' the silver salts of the plate were decomposed by

the invisible rays. One step more—a simple piece of wire placed between the 'window' and the plate—and Lenard would have obtained a shadow photograph similar to those obtained a few weeks later by Röntgen."

It is certainly singular that, even by accident, Lenard should not, during the course of those experiments, have discovered the peculiar property which some at least of the invisible rays, the existence of which he had ascertained, possessed, of throwing the shadow of any substance which absorbed them upon the fluorescent screen. This was the result of the further step taken by Röntgen.

It seems that his researches were being carried on upon somewhat different methods from those adopted by Lenard, and the experiment which led to the discovery of the rays in question, as distinguished from the other kathode rays, is thus described: "Having made a Crookes's or Lenard's tube glow in the way already mentioned, he surrounded it with a close-fitting shield of blank paper, and when the light from the glow was thus effectually intercepted, and the room completely darkened, he found that a paper covered on one side with barium platino-cyanide lit up with brilliant fluorescence when brought into the neighbourhood of the tube, precisely as if a ray of sun or arc light had been thrown upon it. It at once became evident to him that the effect produced was due to the presence of rays differing from those which were intercepted by the black paper in which the tube was wrapped, and what was especially remarkable was that they made the fluorescent screen shine, even at a distance of 6ft. from the covered tube." A full account of his experiments, translated from the German, appeared in *Nature*, of the 23rd January, 1896, and contains a statement of many of the facts that have been published in the ordinary Press, showing the force with which these dark rays penetrate solids. Boards, books, blocks of ebonite, and other substances quite opaque to the rays of the sun or other light-rays, proved to be as transparent to the X rays as glass is to the visible rays. A plate of aluminium half an inch thick was penetrated by them, and they appear to be only effectually resisted by comparatively considerable thicknesses of the heavier metals. When, however, a human hand was interposed between the darkened tube and the screen a shadow was seen, showing the bones darkly, with only faint outlines of the surrounding soft tissues; but, amidst all the recorded experiments with these rays, I have searched in vain for the mention of any attempt to determine whether they are, and, if so, to what extent, intercepted by the combinations of orange and yellow glass used to prevent the action of the ordinary actinic rays upon a sensitized photographic plate. But whatever interest attaches to Röntgen's discovery

from the power which the X rays afford of exploring the human body, its chief importance for theoretical science lies elsewhere. Unlike the electric waves of Hertz, they are not capable of either refraction or polarization, and, although they appear to have something in common with the invisible ultra-violet rays of the spectrum. they differ from them in most respects, and especially in their electric effects. It appears that they do not emanate from the kathode itself, but originate from the glass of the tube where it is struck by the kathode rays, and, whilst these are capable of being deflected by the magnet, the X rays take no notice of it, and pursue their course, in spite of any interposed medium, in perfectly straight lines. What, then, are these rays? For the present the ordinary enquirer must be content with the knowledge we have of their power of piercing substances impervious to all ordinary rays of light, and of recording a shadow upon a photographic film. Whether or not the results of the experiments already made are to be accepted as affording evidence that waves of compression and rarefaction are produced in the so-called ether by the passage of light through it, must remain open until the learned physicists who are now engaged in investigating the structure and movements of the ultimate particles of matter have had time to deal with the application of this new discovery to the solution of the problems involved. Rontgen himself concludes the paper referred to in these words: "Should not the new rays be ascribed to longitudinal waves in the ether? I must confess that I have in the course of this research made myself more and more familiar with this thought, and venture to put the opinion forward, whilst I am quite conscious that the hypothesis advanced still requires a more solid foundation."*

DISCOVERY OF ARGON.

It might well have been thought impossible that any of the constant elements of atmospheric air, which has so frequently been analysed and examined by chemists and physicists in the foremost rank of science, could long have escaped detection, but, singularly enough, it was not until last year that the nitrogen of which it is so largely composed, amounting, in effect, to nearly four-fiths of its volume, was conclusively proved to be associated with an unknown chemical element. The compound character of atmospheric nitrogen had, however, long been suggested, and even to some extent demonstrated, by the older chemists, for we find that Berzelius, a contemporary

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* Since this part of my address was written I have received the April number of *Nature*, in which readers will find papers of the highest interest by Professors J. J. Thomson and Oliver Lodge, on the subject of the Röntgen rays, but the contents do not materially affect what I have ventured to bring before the society.

of Davy, satisfied that it was a compound body, was under the impression that it was associated with an inflammable base combined with oxygen, for which he proposed the name Nitricon. But he is said to have distrusted or abandoned this hypothesis in consequence of experiments made by Davy, who also believed that atmospheric nitrogen was a compound body, of which oxygen formed an element, and endeavoured, but in vain, to detach the latter by means of the vapour of potassium. But his experiments led only to the negative result that the divellent power of potassium was insufficient to overcome the affinity by which oxygen was held in combination with the other elementary matter associated with simple nitrogen. Mr. David Low, of Edinburgh, who published an important treatise on the "Simple Bodies of Chemistry," in 1856, also treated atmospheric nitrogen as a compound substance, and mentioned that, from its known characters, the same opinion had long been entertained, but that, as all attempts to decompose it had failed, chemists had been content to acquiesce in regard to it, in their own maxim, that it must be regarded as simple because they had not been able to prove it compound, whilst he points out that all the known circumstances ought to have led to the juster conclusion that it should be treated as compound, although chemists had not been able to prove it so by means of the agents which they had employed to dissociate its elements. He also mentioned that, although it had theretofore resisted all attempts to dissociate it directly from the substance with which it was evidently compounded, there were reasons for believing that in many unheeded experiments in the laboratory its compound nature had manifested itself, especially in cases in which it was impossible otherwise to account for its presence.

But this point has now been set at rest by recent investigations made by Lord Rayleigh and Professor Ramsay, which have not only resulted in conclusively establishing the compound nature of atmospheric nitrogen, but also in showing that the substance with which it is associated is a gas previously unknown, to which they have given the name of argon. But the question, What is argon? still remains to be solved. So far as present researches into its chemical character have been carried, it is found to possess properties of so peculiar a description as to raise questions of paramount importance for chemistry.

It is well known that, prior to this discovery, Lord Rayleigh had been for many years engaged in inquiries as to the densities of several of the gases, and that he had found discrepancies in many of the results obtained which could only be accounted for in one of two ways,—namely, either by the occurrence of unavoidable errors in experiment or by the

assumption that some of the supposed simple bodies were in reality compound. These discrepancies were especially obvious in the case of atmospheric nitrogen, for when obtained from that source by any of the methods usually employed for the purpose, it was invariably found to be heavier in an appreciable degree than when obtained from any other compound of which it formed a part. This would doubtless have been noticed by Berzelius, or Davy, or Faraday, who had also experimented on atmospheric nitrogen, had any of them compared its relative densities when obtained from that and other sources, such, for example, as ammonia, and yet the fact that nitrogen entered into the composition of ammonia was one of those which led some of the older chemists to infer its compound character. It would certainly be strange if Lord Rayleigh was unacquainted with these older speculations, although, so far as my reading goes, I have seen no reference to them in the published accounts of his experiments. The difference actually found by him between the weight of atmospheric nitrogen and that chemically obtained from its compounds was that its average weight in the former was 1·2572 grammes, whilst in the latter it was only 1·2505, a difference of ·0067 grammes. Many suggestions were offered to explain this discrepancy, all of which, however, were based upon the supposition that atmospheric nitrogen was the purer of the two, and that the nitrogen chemically prepared must still contain some lighter gas. But upon proper test experiments being applied in connection with these suggestions they were found to be untenable, and it soon became clear that the supposed position must be reversed, and that atmospheric nitrogen must have in combination some heavier gas previously unknown. For some time after this discovery the test of separating argon from the atmospheric compound proved to be a very difficult one. Nitrogen, chemically speaking, is an inert substance, by which is understood that it is very difficult to force it into combination with other substances, and it soon became obvious that argon could only be obtained as a residue after removing from any given quantity of atmospheric air all its other constituents. This was effected in several ways, all of which were slow and wearisome. It has, however, been justly remarked that "chemical bodies must be taken as we find them, and that those amongst them which, even in the hands of the best experimentalists, yield only to methods outside of ordinary chemical routine are precisely those whose investigation leads most to the extension of chemical knowledge."

The chemical nature and properties of the new substance have as yet been only partially ascertained, the chief obstacle

to investigations into this branch of inquiry arising from the difficulty of obtaining it in sufficient quantity for experiment; and, in fact, what is known is chiefly negative. Mr. Crookes submitted it to spectrum analysis, the result of which led him to suppose that it consisted of a mixture of two gases; whilst the experiments of Olszewski into its temperature of liquefaction and its critical temperature and pressure seemed also to indicate that it is a compound substance, but that the mixture could only contain a very small proportion of another gas.

Its leading physical properties were more easily ascertained. It was found to be colourless and inodorous, to have a density of about twenty times that of hydrogen, although it is probable that this may be exceeded. It is more soluble in water than oxygen or hydrogen, and therefore it is not improbable that in drinking unboiled water we imbibe a proportionately larger quantity than we inhale in breathing. It requires a very low temperature for liquefaction, Professor Dewar having ascertained that it liquefies at 305° Fahr. below zero, and is converted into opaque ice at 310°. These physical properties, however, have as yet afforded little aid in determining its chemical nature; but, as this question is being investigated by some of the greatest chemists of the day, and, amongst others, by Mendeleeff, Berthelot, and Professors Dewar and Ramsay, we may expect to receive, within a reasonable time, full information in respect to it. In the meantime it is supposed to be a tri-atomic form of nitrogen, as ozone is a bi-atomic form of oxygen; and many circumstances already known—for example, its concurrent appearance in nature with nitrogen, the difficulty of separating them, their common inertness—exaggerated in argon—their common lines in the spectra, their double spectra, and the outer resemblance of their benzine compounds as shown in Berthelot's experiments—are said to lend strength to this hypothesis.

The announcement recently made by Professor Ramsay that he had discovered that argon is contained in a mineral called clevéite, is likely to lead to a rapid increase in our knowledge of its chemical character and properties. A bright-yellow line in the spectrum of the sun's chromosphere had long been observed with interest, and was generally ascribed to an element unknown on the earth, but widely spread on the sun, from which circumstance it had been called helium. Now, this element was lately captured by Crookes in a glass tube in the laboratory, quite unexpectedly, in the course of investigations which Professor Ramsay was making with a view to extracting and analysing the gas contained in clevéite, said to be nitrogen. He communicated his discovery to Professor Cleve, of Upsala (in whose honour the mineral had

been named by Nordenskjold), who at once extracted the new gas, which was submitted for spectroscopic examination to Thalen, one of the best spectroscopists of the day, who confirmed Crookes's statement, but found no trace of argon. Ultimately, however, Professor Ramsay, while boiling clevéite in weak sulphuric acid, not only obtained helium, but also argon, devoid of the gas which is usually found associated with atmospheric argon, and which may be the cause of the high density of the latter. Thus several new forms of gas have already been discovered, whilst more are apparently in view. From these facts it appears certain that the means now available for producing argon in a pure condition, coupled with the further discoveries made in the search for it, are sure to launch both chemistry and physics into a new domain of philosophical inquiry, which will not only materially widen our knowledge of facts and our theoretical views in chemistry, but will probably also lead to some more definite conceptions of the nature and structure of matter.

ART. IX.—*Presidential Address.*

By the Rev. WILLIAM COLENSO, F.R.S., F.L.S.

[*Delivered to the Hawke's Bay Philosophical Institute, 11th May, 1896.*]

> Slave to no sect, who takes no private road,
> But looks through Nature up to Nature's God.
>
> POPE, "Essay on Man."

IN my taking the President's chair on this occasion, being the opening of our sessional meetings for this year, 1896, I must, in the first place, thank you for your having again elected me to this office. And while it is my pleasing duty to do this, and to assure you I will do my best to fill it creditably, I feel a certain amount of diffidential fear lest I may fail, and so not come up to what you may have been led to anticipate; and this arises from many peculiar circumstances, which I need not particularise.

From the published report of our Council for the last year's session, which you have seen, I find there were seventeen papers on various subjects read here by members of this auxiliary branch of the New Zealand Institute during that period. As the last annual volume of Transactions published by the Institute has not yet been received by us, we do not at present know how many of those papers may have been selected for publication in it; I hope, however, that our

society will shortly find that, if not all, a fair proportionate number will have again passed the scrutinising ordeal of the Governors and Director of the Institute.

I confess I would much rather have seen the expected annual volume of the Transactions, as from it we should have learned the number, the variety, and the quality of its papers —contributions from members of the New Zealand Institute scattered throughout the colony. And these papers, or some of them, in brief review I might with pleasure now bring before you, just to show the working of the united society during the past year, and not unlikely serving to stimulate this branch of it to greater exertions.

I have also noticed in our Council's report, just adverted to, that the number of papers read, with the President's opening address and a lecture delivered, were, at least, increased in number above those of the preceding year. As I have said before, speaking from this place, so say I now again, that I should like to see a much larger number of papers, both suitable and interesting, and on various subjects, annually introduced. Moreover, I think it is high time for some, at least, of our older members, who have been so many years in our ship as to have quite served their full term of apprenticeship, to come to the fore and perform their share of duty, if not in the work of papers, yet in the collecting and preserving of specimens in any and every branch of natural science for the museum. And here I will quote a paragraph from my last presidential address from this chair, it being still so very suitable:—

"There is yet another prominent feature in our last report in connection with the relatively fewer number of papers read here during the session of 1887—viz., the still greater paucity of their writers. This, however, should not be, as it throws the working of our ship upon a few hands only; and this, if continued, will surely bring about, not a mutiny, but the stoppage altogether of her sailing. For, in my opinion, this branch of the New Zealand Institute will droop and wither and die if it becomes unfruitful. The ordinary meetings will not continue to be held unless there are original papers to bring before the members; and if this should happen, and consequently no papers from the Hawke's Bay auxiliary appear in the annual volume, then the large number of country and other members, who, from their residing at a distance, are precluded from attending the ordinary meetings, will cease remaining subscribers. In this ship or hive there should be no drones. Our society is both smaller and poorer than other kindred ones in this North Island—Auckland and Wellington. Happily there is no distinction made on this account; nevertheless, we here in Hawke's Bay must feel it,

and therefore it is the more imperative upon us, as a determined and devoted though small band, devoid of those large blessings which our elder sisters enjoy—in rich endowments, princely gifts, resident learned scientific men, extensive libraries and museums—to be active, to be penetrated with that genuine *esprit de corps* which not infrequently more than makes up for the want of everything else. In particular, let the very proper and praiseworthy spirit be shown in your attendance here on the regular nights of meeting—coming, too, in time for the fixed hour of meeting, and also in upholding the proper status of our young society—I mean the carrying-out all the standard rules in their integrity, particularly Rule 3, which, I think, was too often infringed on during the last year's session. I mention this as I have plainly perceived that, if care is not taken, our ordinary meetings are apt to degenerate into those of a low debating-club (*Facilis descensus Averni*); and so we cease to remain an auxiliary branch of the New Zealand Institute—a society founded for a highly different purpose."

And here I think I should remind the members of our Institute that original papers written by other than members themselves may be received and read at our ordinary meetings. Such papers, of course, must be introduced by a member. It would be well for our members to bear this liberal manner of acting in mind. During this last session three papers of this class were read here, written by non-members, and I thank the writers.

Closely connected with the number of papers read is the present number of our members; and I deeply regret to find their number is slowly and sadly decreasing. This ought not to be. Last year our report informed us of "a considerable decrease in the membership, which then stood at eighty-four, the smallest number on the books of the society for many years past." This year the new report gives the remaining number of them as seventy-four, four having resigned and two died, to which, however, six new members have to be added, making the present total of members eighty. Fairly considering the great, the important value of such an institution as this, especially in a newly-settled country, and, with special reference thereto, the great number of educated youths yearly leaving school, one is tempted to ask, Why is it that so few of them are found here with us—if not as enrolled members and co-workers, yet as visitors of our museum and library, and hearers at our stated meetings, which are now thrown open to the public? Is it so, that out of those many youths and young men, several of whom gained high prizes at the various school-examinations, and of whose future career high hopes were entertained, there are none to be found in love

with nature and natural science in all its varied forms, so as to continue and carry on those studies begun at school? Our youth are the hope—the strong hope, the backbone—of this young and rising colony, destined in due time, under God's blessing, to become a great and mighty nation, or a fair and flourishing portion of a still mightier empire, and therefore they should be seeking to grow, to improve, in knowledge and wisdom. Nothing is more sure than this: that school knowledge and attainments allowed insensibly to wither and rust soon become *forgotten;* and, once forgotten, are seldom, if ever, found again. There is a law in nature according to which success is proportioned to the labour spent upon it, both in kind and in degree. Success is attained in kind, for what a man soweth that shall he also reap; success is also proportioned to labour in degree, for he who studies much will have more than he who studies little. In almost all departments it is the diligent hand which maketh rich. And here let me, not only as your elected President *pro tem.*, but as a very old man of some understanding in these matters, and therefore speaking from experience—let me proffer a little sound advice.

The powerful and active enemies of science and of general learning (especially here in the colony) are too great love of holidays and of idleness, of frivolity and of fleeting pleasures, which yield no enduring satisfaction; which generally, if not invariably, look for more, never being satisfied, and mostly leaving "an aching void." And should there be, before the final close, a few hours or days free from pain and extreme weakness for reflection, then the sad heart-rending vista presents itself of *time lost*, of noble, almost god-like faculties abused, of a wasted life! Our classical British poet, Thomson, might well exclaim, while meditating on such scenes:—

> Where now, ye lying vanities of life!
> Ye ever-tempting, ever cheating train!
> Where are you now? and what is your amount?
> Vexation, disappointment, and remorse.
> Sad, sickening thought! and yet deluded Man,
> A scene of crude disjointed visions past
> And broken slumbers, rises still resolv'd,
> With new-flush'd hopes, to run the giddy round.
>
> ("Winter.")

And heartily wishing well to the scholars and youth and young men and women of Hawke's Bay, I would yet add a few more words by way of further illustration, and with the hope of raising thought.

In student-life there are those who seek knowledge for its own sake, and there are those who seek it for the sake of the prize, and the honour, and the subsequent success in life that knowledge brings. To those who seek knowledge for its own

sake the labour is itself reward. Attainment is the highest reward. Doubtless the prize stimulates exertion, encourages and forms a part of the motive, but only a subordinate one, and knowledge would still have a "price above rubies" if there were no prize at all. They who seek knowledge for the sake of a prize are not genuine lovers of knowledge. They only love the rewards of knowledge; had it no honour or substantial advantage connected with it they would be indolent. It is a spurious goodness which is good for the sake of reward. The child that speaks truth for the sake of the praise of truth is not truthful; the man who is honest because "honesty is the best policy" has not integrity in his heart. Would that the parents of families here in Hawke's Bay could be brought to duly consider this, and to perceive the great and lasting advantages and benefits and true pleasures arising from the following of Nature and her manifold teachings, and so direct and lead their progeny into something better than the low frivolities and transient pleasures and waste of time of the present age.

For, believe me, there is a rapture in gazing with a trained eye on this wondrous world. Let us not depreciate what God has given. The highest pleasure of sensation comes through the eye; she ranks above all the rest of the senses in dignity. He whose eye is so refined by culture and discipline that he can repose with pleasure upon the serene outline of beautiful forms has reached the purest of the sensational raptures. There is a joy in contemplating the manifold forms in which the All-beautiful has concealed His essence—the living garment in which the Invisible has robed His mysterious loveliness. In every aspect of nature there is joy; whether it be the purity of virgin morning, or the sombre grey of a day of clouds, or the solemn pomp and majesty of night; whether it be the chaste lines of the crystal on the yonder Ruahine Mountain-range, or the waving ever-changing outlines of distant hills (as those south beyond Havelock and north towards Wairoa) tremulously visible through the slanting rays of the setting sun; the minute petals of the New Zealand daisy, or the overhanging forms of mysterious ancient forests: it is a pure delight to see. I hope a better day is at hand for our Government schools, when Education Boards (if existing) or Committees (when formed of proper literate men) will pay full attention to this one great qualification, or main desideratum, on the part of teachers seeking situations—viz., their love for natural science and for scientific study, and their aptness to teach such both out of school as well as in school. Such a teacher in a country school would prove a real blessing to the youths under his care, and be a great means of keeping them from degenerating on leaving school, as well as preserv-

ing them from "larrikinism." Scientific study should be largely inculcated by kind and plain words, by manuals, and by example, for science has extended into all portions of life. What I mean by a scientific education is not the mere confined knowledge of that one branch taught, or one thing brought more particularly under consideration, whether Euclid's problems or natural science—the science of living things, as seen in the wondrous, complex, yet perfect and beautiful structure of a fly, a shell-fish, or a moss (for beauty's best in unregarded things)—the mention of which as a useful study is too often met with a "*Cui bono?*" For the opinion is often expressed that certain scientific pursuits are not compatible with the business pursuits of life. But there is no greater fallacy than this, as we may see in the living instances of many eminent men of our time—Sir John Lubbock, for example. A true scientific education is the teaching of the power of observing, the teaching of accuracy, the difficulty of attaining to a real knowledge of the truth, and the methods by which one may pass from that which was proved to the thought of that which was also capable of being proved. The first thing to learn is the power of observing, the power of seeing things in their relations to other things, and the modifications they might undergo. This, though a rather difficult thing, is attainable. Science teaches not only how to observe, but how to record facts, and how to arrive at general conclusions upon facts. The habit of accuracy which science inculcates makes a man accurate in the ordinary business and pursuits of life. There are many people—good people—who would not tell a lie, but for their lives they seem as if they could not tell the exact truth. Now, science teaches the difficulty of attaining truth, and shows how to arrive at it. It is said of the celebrated John Hunter, who delighted in plain language, that he once said, if he wished to sum up his advice to students it would be, "Don't think; try." What he meant was, when one was satisfied about certain principles, do not think that you can think what must necessarily follow, but try, test, experiment, observe, record facts, then you would see whether what you thought was true was really true.

Moreover, scientific processes also gratify our love of novelty, of wonder. All have an insatiable appetite for the wonderful; civilised man is still everywhere like the Athenians of old, eagerly inquiring after "some new thing." And to a certain extent (if, indeed, such should ever be limited) this common trait is conducive of great good, as, in spite of many failures, it continually leads to the advancement of our race.

I have already barely mentioned the death of two of our members. As, however, this is unusual with us, I would offer a few observations concerning them. Those two gentlemen,

Mr. F. H. Meinertzhagen and Mr. H. S. Tiffen, were old and valuable members of our Institute; both of them were original members from its foundation in 1874 (when lovers of natural science were few who joined us), and these require a special brief notice.

Mr. Meinertzhagen resided for several years at Waimarama, a little south of Cape Kidnappers, where he carried on his natural science investigations, and from him I received several letters and specimens, and also interesting letters from London after his leaving New Zealand. He early became a life member, paying the £10 fee—and here I may remark that at the same time, or, rather, for ten years preceding, he was also a member of the Auckland auxiliary branch, of which society he was also a life member. This double membership, with their expenses, and not being able to attend any of our meetings owing to the distance of his residence from Napier, shows his appreciation of natural science and of our New Zealand Institute. A paper of his on a new species of *Aplysia* will be found in the "Transactions of the New Zealand Institute," vol. xii., p. 270, which also further indicates his modesty and kindheartedness.

Mr. H. S. Tiffen also was one of the founders of our society. Although he wrote no paper for our meetings, he was always a warm supporter of them, while his beautiful and extensive garden, greenhouse, hothouse, and ferneries were always cheerfully open at our service. From the ferneries especially, containing such a large and varied collection of both foreign and native ferns, both Mr. Hamilton (our late curator) and myself have derived much valuable, true, and living information with specimens. Mr. Tiffen, being a devoted lover and disciple of Flora, introduced a large number of flowering-plants, shrubs, and trees from various parts of the globe regardless of expense, his flower-garden, the admiration of visitors and tourists, being the best one in Napier, if not on the whole east coast of New Zealand.

Our society being a branch of the New Zealand Institute (and bearing in mind the ancient, natural, and instructive Roman fable by Menenius Agrippa to the mutineers, of the body and its members, "Livy," ii., 32), I should not omit to bring to your notice, with all due respect, the death of another member of the New Zealand Institute, one of the first scientific men, if not the earliest resident pioneer of science, in New Zealand—the late Hon. W. B. D. Mantell, M.L.C., F.G.S., &c., with whom I was always most friendly acquainted. Mr. Mantell, although not a member of our branch society, was a member of the Wellington auxiliary branch from its beginning, and also one of the founders of the still earlier Wellington Philosophical Society, and one of the nominated

governors of the New Zealand Institute from its creation in 1867. Mr. Mantell arrived in New Zealand in 1840, and worked hard and long in the pursuit of natural zoological science, especially in the collecting fossil osteological remains of those many kinds of enormous land-birds (once common in New Zealand, but long extinct) popularly known by the name of *moa*, though now separated into several distinct genera by the aid of still more extensive and perfect modern acquisitions, obtained from all parts of the colony, in which scientific work I may also (and with pleasure) mention the name of our former respected and indefatigable secretary and curator, Mr. Augustus Hamilton, of whose loving zeal and assiduity and knowledge our museum bears ample testimony. Indeed, the closing word of Sir Christopher Wren's epitaph (the architect of St. Paul's) is equally applicable here to Hamilton—"*circumspice.*"

And, having made that little digression, I may here fitly quote, from a late paper of mine touching on the moa and Mr. Mantell (read before the Wellington Philosophical Society in 1892), what Dr. Mantell, his father, had published respecting the first lot of moa-bones he had received from his son in New Zealand. The Doctor says, "The first collection sent to England by my son in 1847 consisted of nearly 900 specimens; I gave Professor Owen the exclusive privilege of describing them."* I feel the more inclined to relate this circumstance as being an apt illustration of the pursuit of knowledge under difficulties, and as an encouragement to our young men of this generation and district to "go and do likewise."

Before, however, I quit this sad subject there are yet two more names I would bring before you from the long and mournful death-roll of men of science in 1895. The first is that of the Right Hon. Thomas H. Huxley, LL.D., F.R.S., and P.C., who died in June last. Mr. Huxley was also an honorary member of our New Zealand Institute, having been elected so long back as 1872 (together with Sir George Grey, in that year). He had also been out here in the southern seas as assistant-surgeon on board H.M.S. "Rattlesnake," on a surveying expedition in Torres Strait. During his four years' cruise and service on board the "Rattlesnake" he wrote several scientific papers, which were sent home by him to England, and published during his absence. I well remember this ship, with Captain Hobson (afterwards our first Governor), in 1836, at anchor in the Bay of Islands; and mentioning this serves to bring vividly to mind our distinguished New Zealand botanist Sir J. D. Hooker, who had also filled a similar official situation on board H.M.S.

* "*Status quo*": Trans. N.Z. Inst., vol. xxiv., p. 472.

"Erebus," which ship (together with the "Terror," her consort, forming the antarctic expedition), wintered in the Bay of Islands in 1841. Though Mr. Huxley has not been particularly connected with New Zealand matters, yet of him it may be also truly said, as of the great navigator Captain Cook, he is "the man of all countries, all peoples, and all times." Several other good reasons I certainly have for bringing his name before you on this occasion arise from the facts of his having long been a member of the Royal Society—and at one time its President—and of the determination of the Committee in London to erect a suitable memorial to his memory, to be placed with those to Owen and to Darwin in the Natural History Museum, South Kensington; and of the Committee writing to me (as a member of the Royal Society) and to others of us here in New Zealand to consent to have our names placed on the Committee-roll, and further to assist in this great national work; and especially from the fact of Mr. Huxley having been actively engaged down to the last hours of his life in promoting the superior and free education of youth in the colonies. From official papers lately to hand I find that at the first meeting of the Committee their list, with His Royal Highness the Prince of Wales at the head, included more than seven hundred eminent names, many of them being distinguished foreigners. The closing sentence from the speech of the President, Royal Society, Lord Kelvin, who proposed the first resolution, I may briefly bring before you: "His moral lessons from his biological work extended even into the field of politics, and his contributions to thought in respect of theology in themselves are such as to put Huxley's name and fame in a very high position indeed, as a man thoroughly determined to give all the benefit he could to mankind—as a worker who gives his life, who sacrifices his health, who sacrifices his time, who gives up everything for the advancement of science; but, as he tells us himself, with an object which he felt to be even greater than the advancement of science, the promotion of the welfare, moral and material, of mankind—who deserves a memorial or a monument better than Huxley?"

Lord Playfair also, in supporting the resolution, said, "It is scarcely necessary to say one word in regard to the eminence and the scientific position of Professor Huxley; but it has been my privilege to be associated with him in many of his undertakings and labours as a public man. . . . In higher education the Scotch University Commission benefited by his wise counsel and breadth of culture. The present position of technical education also owes much to the advocacy and the scientific lectures which Professor Huxley gave through the country. There is one labour in

which to the time of his last illness I had great pleasure in being associated with him—that was, in the establishment of scientific scholarships of £150 a year in almost every college and university, not only in the United Kingdom, but in the Empire of India, and throughout all our colonies. That was a subject very dear to Professor Huxley's heart. . . . He was a much-valued adviser in all matters relating to the establishment of these scholarships. They are all research scholarships, and are now exercising a benign and important influence over the science education of our great empire."

And our old, well-known, and staunch New Zealand friend, Sir J. D. Hooker (chairman of the provisional committee), in moving the second resolution, said, "We both entered the public service as assistant-surgeons and volunteer naturalists in the royal navy. Before Professor Huxley went out in the 'Rattlesnake' the choice lay between us for the appointment to that vessel, and, fortunately, the choice fell upon him. Immediately upon his return a strong friendship sprang up between us, which has lasted forty-five years, throughout which he has been one of my staunchest and firmest friends. This friendship has affected me through life, and I owe a great deal of my success in scientific life to the advice, the stimulus, and the example which Professor Huxley set me during a long career."

Here must end my quotations. I believe that circulars respecting this great national movement have been sent to some of the members of this Institute, and to several other residents here in Napier and Hawke's Bay, by Professor T. J. Parker, F.R.S., of Dunedin, which is another good reason for my bringing this subject before you.

The second name is another of literally world-wide fame—Louis Pasteur, who passed away from us in September, 1895. Fifty years ago, before he entered on his grand biological work, Pasteur made a discovery of first-rate importance in physics and chemistry—the formation of crystals. For ten years he was chiefly occupied with researches related to the subject of that great discovery. Near the end of 1857 he entered on the line of research to which he devoted the rest of his life, and by which he conferred untold benefits on humanity and the lower animals. Helmholtz had in an earlier work proved almost to a certainty "that the actual presence of a living creature ["vibrio," as he called it; "bacterium," as we more commonly call it now] is necessary for either fermentation or putrefaction." Pasteur gave complete demonstration of that conclusion, and early expanded it to vast and previously undreamt-of extensions of its application. From Pasteur's discoveries, Lister was led to work out the principles of antiseptic surgery, the practice of which he commenced in the Glasgow Royal

Infirmary in 1865. Having been led to trace microbes as the origin not only of fermentation and putrefaction, but of a vast array of destructive blights happening to plants and animals—vines, silkworms, birds, cattle, and mankind—Pasteur was forced to take up the question, as of supreme importance, "Whence came these microbes, and what are their antecedents?" We are sometimes told, "from warmth and moisture"—and this, too, in scientific journals of 1895, under the more learned name, perhaps, of "abiogenesis," or the fortuitous concourse of atoms! Without wasting words to prove theoretically that while stones falling together may, as we all believe they have actually done, make a solar system with a habitable planet or planets, they cannot make a man, or a microbe, or an organic cell, with its property of heredity. Pasteur set about practically to trace the antecedents of every microbe he met with; and he found for it in every case a living thing, whether in the air, or in water, or in earth. During nearly all the latter part of his life, and to the end, Pasteur devoted himself to biological research, and to vigorous practical realisation of its benefits for the world. And we here, in this far-off colony, are receiving benefits from Pasteur's labours and discoveries. I have felt constrained to say these few words in honour of that great chemist and biologist.

And now for a few words respecting some of the higher scientific discoveries of the past year. To this subject, however, I can only make very scanty allusions; but this is a small matter, as you have already heard of them from better-informed sources.

Probably the discovery of a second gas as a component in our common atmospheric air stands pre-eminent. I allude to helium; its great ally being argon, also lately discovered by Lord Rayleigh. Then there is anti-toxin, as a remedy in certain forms of severe disease; and more lately the curious and highly-important discovery by Professor Röntgen of photographic rays, or the "new light," by which near objects unseen by mortal eye, through their being imbedded and hidden in opaque bodies, are made clearly visible. This interesting discovery, which is likely to become very serviceable in some cases of surgery, has already attained a high position in the medical world, especially on the Continent of Europe. Indeed, we are continually receiving notices from abroad of fresh and further useful and surprising discoveries being made in this direction. I shall be able to show you a plate as an object-lesson representing its operation, which will cause it to be the more readily understood. But I do not exactly fall in with the statement so commonly made in connection with this important discovery—that the camera of the photographer can now

make clear and plain what is invisible to the naked eye—that is, as if the naked human eye at its highest standard was the acme, the *ne plus ultra*, of vision. For such use of photography has long been known—at least to astronomers; for hundreds of stars, some of great magnitude, yet invisible through the best telescopes, are made known to us thereby, and have been correctly mapped.

Moreover (and without entering on the wonderful and complex and perfect physical mechanism of the human eye), we may see in the animal kingdom, especially in the class of birds, how vastly their powers of seeing exceed those of man. Let us briefly consider this, as it contains an immense field for interesting and pleasurable thought, and some of the objects are common, near at hand, and easily comprehended—omitting the well-known owls, with their strong nocturnal powers of vision far surpassing that of man. Take, for instance, the common Maori kingfisher (*Halcyon vagans* = Kotaretare) I have watched this bird, or the pair of them, at the season of rearing their young, quietly perched on an outstretched dead branch of a lofty timber tree overhanging a streamlet, 50ft.–60ft. high, when suddenly, like an arrow, the bird descends into the water below, and immediately emerges with a tiny fish in its bill. So, also, I have at other times noticed them to act on a cricket, beetle, or lizard in the grass and low herbage. A still commoner show of the superior sight of birds, even when on the wing soaring on high, is also everywhere around us exhibited—over land by the hawks discerning a mouse running among the fern, or a young duckling or other water-bird among the long sedges and rushes of the swamps; over the sea by the various species of gulls and terns, who, notwithstanding the rippling and the colour of the water, descend with rapidity like a leaden ball beneath the wavelets, and arise with their prey. But all this is yet surprisingly surpassed by the giant vulture—the condor of the Andes. Here I will, with pleasure, quote the natural and admirable words of Darwin, who had so frequently witnessed them in their natural haunts: "The condors may often be seen at a great height, soaring over a certain spot in the most graceful circles. On some occasions I am sure that they do this only for pleasure, but on others the Chileno countryman tells you that they are watching a dying animal, or the puma devouring its prey. . . . When an animal is killed in the country it is well known that the condors, like other carrion-vultures, soon gain intelligence of it, and congregate in an inexplicable manner. In most cases it must not be overlooked that the birds have discovered their prey, and have picked the skeleton clean, before the flesh is in the least degree tainted. . . . Often when lying down to rest on

the open plains, on looking upwards I have seen the condors sailing through the air at a great height. Where the country is level I do not believe a space of the heavens of more than 15° above the horizon is commonly viewed with any attention by a person either walking or on horseback. If such be the case, and the condor is on the wing at a height of between 3,000ft. and 4,000ft., before it could come within the range of vision its distance in a straight line from the beholder's eye would be rather more than two miles. Might it not thus readily be overlooked? When an animal is killed by the sportsman in a lonely valley, may he not all the while be watched from above by the sharp-sighted bird? And will not the manner of its descent proclaim throughout the district to the whole family of condors that their prey is at hand?" (Darwin's "Naturalist's Voyage," pp. 183–186; a book that should be in the hands of all our rising youth.)

Still, while we here see the enormously superior powers of unaided vision as shown by birds, man, too, not unfrequently exceeds that of the common human powers of range, of which I myself have known instances in New Zealand, and therefore am inclined to relate them. In former years I have satisfactorily proved this, in viewing with my telescope the planet Jupiter, and also the cluster of stars called Pleiades in the constellation Taurus, when I found that the Maoris could see more stars in the Pleiades with the unaided eye than I could, for, while I could only see clearly six stars, they could see seven, and sometimes eight. This feat has also been done at home in England, though very rarely, some few there having distinguished as many as twelve stars. This cluster has been mentioned in poetry as far back as Hesiod, B.C. 900 (contemporary with Homer), who alludes to them as the Seven Virgins. In the ancient MS. of Cicero's "Aratus,"* preserved in the British Museum, the stars are named Merope, Alcyone, Celieno, Electra, Maia, Asterope, Taygeta. Though they have ever borne the name of the "seven stars," yet to ordinary eyes six only are visible. My reason for mentioning this ancient astronomical MS. of the third or fourth century is that I happen to have a copy of it with a *fac-simile* of the faces of those seven virgins which I think will interest you.† To return: the Maoris also could clearly distinguish and point out with the naked eye the satellites or moons of Jupiter, with their respective and changing positions.

In botany (having read two or three papers containing descriptions of some newly-discovered New Zealand plants before the Institute during the last session, which I hope may

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* "Aratus," Greek Astronomer, 277 B.C.
† "Archæologia," vol. xxvi., art. iii., p. 47.

be published in the forthcoming volume) I shall merely call your attention to two recent noticeable successes in the cultivation of remarkable plants in our colonies; one being that of the date-palm (*Phœnix dactylifera*) in the West Indies (Antigua), where it now bears ripe fruit, and, no doubt, will ere long become an article of commerce; and one being the magnificent water-lily (*Victoria regia*) of the River Amazon, that has lately flowered at Sydney, though many years ago (1849–50) it flowered in its big tanks at the Royal Gardens, Kew, and also in the private gardens of the Duke of Devonshire and the Duke of Northumberland, when it was fully described by the late Sir William Hooker. (Of this remarkable plant I hope to show you by-and-by some large coloured drawings from Sir W. Hooker's magnificent work, together with some interesting extracts from the writings of its fortunate early discoverers.)

I have especial reasons for calling your attention to the date-palm, it being one of the oldest-known cultivated plants yielding food for man; its fruit is also well known here. This plant and the banana, *Musa sapientum* (of which I read a paper here two years ago),* are the only two prehistorical fruit-producing plants. The date-palm flourishes in Egypt, Nubia, Morocco, Persia, and Arabia, and even India, and is now, as ever, commonly used by a very large number of mankind, and that, too, in its native country, in a far more economical and useful manner than it is here by us, we only eating the fleshy part of the fruit, rejecting the hard seeds or stones, which are also used by the Arabs for food; for, hard and dry as they appear, they are ground into a kind of coarse meal, on which the goats and camels feed with greediness, and in the longest marches across the desert neither man nor beast require other food, if they have also a little water or camel's milk to allay their thirst. And, as the banana has of late years been naturalised and extensively cultivated in some of our British colonies, and thus become an article of commerce, so, it is hoped, in due time the date will also be. Although the date-palm is frequently mentioned in the Bible (particularly in the Old Testament), and always with approval, yet, curiously enough, there is not an instance of its being spoken of as producing a fruit valued as a food for man.

I should not pass unnoticed two great events of this present year, which have been much talked of, one being natural and sure, and one dependent on the hardihood and ability of man. The former is a remarkable total eclipse of the sun, which will take place on the 8th–9th of August, but, unfortunately for us, will not be visible here in New Zealand. Its

* Trans. N.Z. Inst., vol. xxvi., p. 334.

appearance will commence about two hundred miles north of Scotland, out at sea, and will cease on the Pacific Ocean at 180 degrees of east longitude and 20 degrees north latitude. Though invisible here, I mention it for two reasons: (1.) It is exciting active scientific consideration at Home and throughout the old civilised world, so that great preparations are being made for the proper observation of it. Some months back the "Norse King," a large steamer of 3,000 tons, was chartered to take an astronomical party to Vadso, in Nova Zembla, in order to observe this eclipse; while similar arrangements will also be carried out for Japan. On this occasion two instruments will be used, one called a cœlostat and the other a heliostat, their purpose being to deflect the rays of the object into a fixed telescope, instead of having to put the telescope itself into motion. The importance which attaches to the investigation of the sun during eclipses is very great, for it is only at these times, and during brief occasional opportunities, that knowledge of its physical construction and conditions can be obtained. It is only when the brilliancy of the flood of light which emanates from its whole surface is shut off from our eyes by the intervening moon, and we are left in the darkness of the lunar shadow, that we are able to see the corona radiating from the vast orb, and here and there within its zone the remarkable outburst of still more luminous combustions—certain brilliant star-like points, commonly called "Baily's beads," and irregular flame-like protuberances on the dark edge of the moon, usually of a pink or rose colour. Although solar eclipses are annually in greater number than lunar eclipses, they are more locally distributed, and, whilst the shadow of the lunar eclipse rests over a full hemisphere, the solar eclipse is a mere streak on the earth's surface. Hence the necessity for expeditions of observers. And (2) to tell you what I have myself observed, in a small way, with reference to the corona radiating from the sun, or, more particularly, those irregular flame-like projections, but not during an eclipse. During several years, in the month of December, and about the middle of it, or on or near to our longest day—the 21st—I have been employed in watching with my glass the sun at sunset and seeing it descend south-west beyond the Ruahine Mountain-range, about fifty miles distant, when two things I have noticed—one being a kind of corona or areola, with long, attenuated, red flames, ever changing, proceeding from its margin (much as the sun is represented in drawings of it when eclipsed), and one an abrupt bare rock or broken precipitous crag on the crest of the mountain standing out in bold relief and black shade in front of the sinking orb. These interesting sights are only to be seen for a few evenings, owing to the daily change in the apparent position of the sun travelling

a little more either to the north or to the south, as the case may be,—which is also so clearly shown by the bare, perpendicular edge of the rock on the crest; and I think that those red, flame-like emissions are at these moments seen owing to the intervening dark mass of the mountain-peak or -crag, which occupies a similar though smaller position to that of the dark body of the moon during a solar eclipse. Of course the whole solar object is only that of the image of the sun correctly reflected in the clear atmosphere above, and lasting but a very short time. I may mention that I had to pay a little for my temerity in looking steadily at such a bright object without using a coloured glass, for during some time after so observing it whatover I looked at wore a greenish-yellow hue, some objects, owing to their natural colours, being rendered disagreeable This, however, gradually wore off. I think I have observed this pleasing natural phenomenon during four or five years, but not consecutively, owing to the sky being sometimes clouded at sunset. I have often thought of writing a short paper concerning it, and giving sketches of its appearances; one of them I now lay before you, made, however, mainly from memory. Other persons, no doubt, in days to come will also have the pleasure of observing this peculiar spectacle from this spot on Napier Hill.

And here I cannot refrain from expressing my belief—notwithstanding the enormous and wonderful advances the true knowledge of astronomy has made of late years, almost (to use a well-known colonial phrase) "by leaps and bounds," and, also, how very much of this superior knowledge is now commonly and daily taught in our public schools—that many—too many—of our rising generation are really no better off, no farther advanced, for all this imparted and surely-grounded scientific knowledge than the ancients were when they firmly believed that the glorious starry heavens above them were just as a fixed glass (or metal) dome over their heads, and the stars placed there as twinkling lights to give light by night to the earth, which earth, moreover, with its contents, was also the principal part, the chief, of all creation, or of the universe.

Without expatiating on the wonders of astronomy or the knowledge of the stars—on the grand, far-reaching, and captivating subject of the immensity of space; its gloriously never-ending infinitude, and the hundreds, yea thousands, of stars—other worlds, never yet seen by mortal eye, which even our best telescopes do not—cannot—reveal, yet the more modern science of photography has faithfully made known and fixed—I would briefly and in plain words mention a few of the more striking heads of this branch of science, which perhaps are but little known or considered.

(1.) The large and ever-increasing number of planets now known—nearly two hundred—as compared with the small number known to the ancient astronomers (six or seven with the moon); most of them also having been discovered during this century; each planet, like this globe of ours, correctly and everlastingly pursuing its uniform course in its own proper orbit around the sun in the solar system, without the least deviation therefrom.

(2.) The incalculable number of stars as of late years revealed by their (so to speak) thickness in depth, the same having been to some extent gauged. And, as I wish you all to clearly understand me, let me endeavour to put this term into plain language. Suppose our great New Zealand forest began here on the very edge of the sea-shore in Hawke's Bay and extended thence fifty miles over yonder plains to the base of the Ruahine Mountain-range, or even over a continuous flat country to Cook Strait; and suppose a boat landing for the first time here on the beach, and officers and men going up to the margin of the said big forest, they could only see the outside trees forming its margin, or, at most, a very little way into the forest; and now, supposing further a straight road was cut from the entrance right on to the farthest end of the said forest; and now look along this far-extending vista through the trees with a glass, and for the first time the beholder would know something more of the expansion—of the thickness, of the depth, of the multitude—of trees of the forest before him. Well, just so it is with the stars. These which we see on the clearest nights are but few in number in comparison with those others unseen by our eyes lying far beyond them, but which, as to depth and thickness, have been in part gauged by our greatest modern astronomers. The greatest number of stars visible at any one time to the unassisted human eye above the horizon is no more than about two thousand, including every star as low as the sixth magnitude, although, and very likely, some of you may have believed you could see many more; but this fallacy is an optical delusion, mainly owing to their scintillations. The minute invisible ones, however, composing the groundwork of the heavens have been counted by tens of thousands, or even by hundreds of thousands. With telescopic aid the observable stars are too numerous for any accurate determination of their number. M. Argelander, a zealous German astronomer, has, however, several years ago, actually published a catalogue of the exact positions of no fewer than a quarter of a million of stars greater than the tenth magnitude.

Here in our southern skies we have several splendid constellations, which many a European astronomer would rejoice

to see, as Argo Navis, Crux Australis, the Milky Way between Scorpio and Centaurus, with the two neighbouring first-class stars in the legs of the Centaur, commonly called the "Pointers." Moreover, in the same region, and among them, are some curious and peculiarly-attractive objects, very plainly visible on clear nights. I will just refer to some of them:—

(1.) Those two dark adjacent spaces, called by the old navigators "Coal-sacks," near Centaurus and the Southern Cross; these black and apparently starless vacancies are, however, occupied by many telescopic stars.

(2.) Two others, distinct white patches, known by the name of the "Magellanic Clouds," are not far off from the Coal-sacks, the upper being termed the "Nubecula Major," and the lower the "Nubecula Minor."

(3.) The constellation Crux Australis, or the Southern Cross, always visible, and forming with the two "Pointers" such a glorious sight on a starlight night, has ever been an object of universal attraction. The upper and lower stars, being of similar right ascension, are always on the meridian about the same time, and consequently serve to indicate the approximate position of the South Pole, which is distant about 27° 38′ from the largest and nearest star in the Cross. Here with us this constellation never sets below the horizon. It also presents to our view the daily movements of a south circumpolar star, so beautifully shown by the group of four stars composing it. In the course of the day the constellation will have made a complete circuit round the South Pole. In this week (of May) those four principal stars are on the upper meridian at 8.45 p.m.; on the next day, at 2.44 a.m., the earth will have turned on its axis through one-quarter of its revolution; the stars will therefore apparently have passed over one quadrant, or the fourth part of the circuit, being at that time due west of the South Pole. At 8.43 a.m. they have performed one-half of their circuit, being now near the horizon on the lower meridian. At 2.42 p.m. they are due east of the South Pole, while the complete revolution is made at 8.41 p.m. At the hour of midnight this constellation is in the four positions—north, west, south, and east of the South Pole—at the end of March, June, September, and December respectively. The two principal stars in Centaurus (already mentioned) are both easily recognised above Crux Australis; Alpha Centauri, the celebrated double star, being that nearer the meridian, while Beta Centauri is between it and Beta Crucis, the most easterly of the four principal stars in the Cross. Alpha Centauri is one of the largest double stars in the heavens, and one of the nearest to our solar system. This double star has been frequently observed for the determination of its parallax.

A few observations from our early scientific and thoughtful voyagers may prove interesting:—

Captain Basil Hall, during a cruise in the southern ocean, refers to the varying position of the stars of the Southern Cross as seen from his ship at sea. "I have observed it," he remarks, "in every stage, from its triumphant erect position, between 60° and 70° above the horizon, to that of complete inversion, with the top beneath, and almost touching the water. This position, by the way, always reminded me of the death of St. Peter, who is said to have deemed it too great an honour to be crucified with his head upwards. In short, I defy the stupidest mortal that ever lived to watch these changes in the aspect of this splendid constellation and not to be in some degree struck by them."

Again, the remarks recorded by M.M. von Spix and Karl von Martius, in their account of their scientific travels in Brazil in 1817-20, give a very fair specimen of the feelings experienced on these occasions. It is related by them that, "on the 15th June, in lat. 14° south, we beheld for the first time that glorious constellation of the southern heavens, the Cross, which is to navigators the token of peace, and, according to its position, indicates the hours of the night. We had long wished for this constellation as a guide to the other hemisphere; we therefore felt inexpressible pleasure when we perceived it in the resplendent firmament. We all contemplated it with feelings of profound devotion as a type of our salvation."

The scientific Humboldt has expressed his thoughts in almost similar terms. Referring to his first view of the constellation, he observes that, "We saw distinctly, for the first time, the Cross of the South, on the night of the 4th and 5th of July, in the 16th degree of latitude. The pleasure felt on discovering the Southern Cross was widely shared by such of the crew as had lived in the colonies. In the solitude of the seas we hail a star as a friend from whom we have been long separated. Among the Portuguese and the Spaniards peculiar motives seem to increase this feeling—a religious sentiment attaches them to a constellation the form of which recalls the sign of the faith planted by their ancestors in the deserts of the new world." And, again, Humboldt remarks, "How often have we heard our guides exclaim, in the savannahs of Venezuela or in the deserts extending from Lima to Truxillo, 'Midnight is past, the Cross begins to bend.'"

I feel the more inclined to give you those items as not infrequently in my own lonely night-watches on the open plains during my long travels in the olden time, fifty to sixty years ago, I have been visited and impressed with similar thoughts and feelings in looking up and contemplating the

sky, most especially on some very calm and clear night when, in addition to those constellations and stars already mentioned, I have also had those of Orion, Taurus, Scorpio, Canis Major, and others, and sometimes (as lately here) the brilliant planet Jupiter—together forming a glorious mind-elevating sight. At such seasons, alone beneath the solemn vault of heaven, when the stars were looking down in their silent splendour, an overpowering sense of high feeling steals over one—of time and eternity—of man's littleness and God's greatness. Yet too often, accustomed as we are from our youth upward to see Nature's works outspread before us in eternally renewing riches, we commonly pass them coldly by.

There is also another pleasing natural sight close at hand —the silent, orderly, yet ever-changing march of the regent of the night, the moon, across the vault of heaven: not merely to note its different phases night after night, but also its conjunction with the planets and larger stars, as given in the "Nautical Almanac"; especially to note its passing between the earth and one of the larger really bright stars—to see how instantaneously the star disappears when hidden by the moon, and how soon and clearly it reappears when the moon has passed by. It is mainly from this well-known appearance that astronomers have fairly and reasonably deduced the fact of there being no inhabitants in the moon, as that single natural phenomenon shows us that the moon has no atmosphere around it, for if it had the star would have been hidden thereby before the moon should pass it.

Yet another curious and little-known item respecting two of our greatest southern stars—Achernar, in Eridanus, and Canopus, in Argo Navis—is this: that these are the only two which never rise above the horizon of Europe whose names have been derived from the ancient astronomers, showing clearly they were anciently known to them.

To return: The latter of those two great events alluded to by me as taking place this year is the antarctic exploration, which is now sought to be conducted and carried out on a grand and novel scale, even to the wintering there far within the Frozen Zone and not far from the South Pole. And this daring achievement, I have no doubt, will some day be effected; but, for my part, I do not anticipate any great additions to the sciences of zoology, botany, and geology.

The remark has more than once been made to me that so much has been done of late years in the natural sciences, zoology and botany especially, in the discovery of new species in New Zealand, that now little remains to be done. This, however, is not correct; there are hundreds of animals and plants in our colony yet unknown to science waiting to be detected and made known. Take, for instance, two small yet

perfect genera of mosses—*Grimmia* and *Orthotrichum*—hitherto only known, each genus, by four to five indigenous species, but in the last volume (xxvii.) of the "Transactions of the New Zealand Institute" Mr. R. Brown, of Canterbury, has described no less than thirty new species of *Grimmia* and forty new species of *Orthotrichum*. In the same volume also are some scores of new species of the smaller animals described Plenteous harvests yet await the patient and zealous seeker and observer; but, even if it were not so, the natural delight arising from closely contemplating the wondrous and manifold operations of nature is beyond expression a rich reward. It has been recently observed that "discovery crowds so quickly on discovery that the truth of to-day is often apt to be modified, or amplified, by the truth of to-morrow." True, yet a single fresh fact may throw a wholly new and unexpected light upon the results already attained, and cause them to assume a somewhat different aspect.

In conclusion, I should like to say a few more words (it may be my *last* words) on the beauties of nature, by which we are surrounded on land and sea, in the hope of inciting some one of my more youthful audience to come out and enlist under Nature's maternal banner. For while, on the one hand, I know (alas! too well) that there are but a very small number at present inclined that way, yet, on the other hand, this is partly owing to the want of some good, kind, efficient, and loving teacher to strike the dormant chord within the breast that awaits the sympathetic touch, when, like a common match or an electric spark, it immediately responds, and the long latent but now never-dying flame is enkindled, and a new life begins.

It has long seemed to me that the good time is coming, and ere long, perhaps, will suddenly come, when some loving scientific teacher in a school (it may be in a retired country one) will be led to begin this good and useful work—at first in a humble, unpretentious way, but ere long to be warmly adopted by a whole band of willing, loving, active, eagerly-inquiring young disciples, whose wholesome and pleasing pursuit after the attainment of natural science will be amply rewarded to themselves, and followed after by others; for once begun in reality such is sure to spread, being a matter of truth and life.

I would that I might see this welcome movement begun before that I shall have to say my last farewell to you and to Napier.

Lastly, in closing my long address, I would ask your indulgence for two things apparent in it—the one its being rather irregular (written at intervals, in various moods, between paroxysms of pain); the other its being generally of a

homely nature—that is, of things and matters near at hand—lying around us; of things, it may be, that you all knew before; yet, I trust, all done with the very best intention.

I trust you will have perceived that, while throughout my address I have avoided trenching upon theological matters, there is a silver thread of true religion running through it. Further, as pertaining to the great object of the New Zealand Institute, I, as an aged minister of religion and a fervent disciple of Nature, and with increasing convictions of the truth (soon by me to be realised), would say one word more to my audience, *re* our talents and our time here: that as you sow now you will reap hereafter. Young friends, don't waste time, don't abuse talents; seek to make the best use of both. Our bodies will remain, but our minds will go with us!

And, in a few beautiful and expressive lines of our classical English poet, Thomson (already quoted from by me), I close:—

> Father of light and life, thou Good Supreme!
> O, teach me what is good; teach me *Thyself!*
> Save me from folly, vanity, and vice,
> From every low pursuit, and feed my soul
> With knowledge, conscious peace, and virtue pure—
> Sacred, substantial, never-fading bliss.
>
> (*"Winter."*)

Art. X.—*The Maoris To-day and To-morrow.*

By H. Hill, B.A., F.G.S.

[*Read before the Hawke's Bay Philosophical Institute, 14th September, 1896.*]

There has lately been presented to the Houses of the General Assembly a State paper dealing with the census of the Maori population.

This census was taken in February of the present year, in anticipation of the census of the colonists which was taken in April. The circular that was addressed to the enumerators by the Under-Secretary of the Department of Justice asks that the returns may be accompanied "with a report on the increase or decrease of the natives within each district since the last census was taken; the general state of health of the natives; any disease or epidemic which may have visited them; and any further information bearing on the statistics of Maori population which the enumerators might consider of interest."

There were fourteen enumerators in all, and their reports are attached to the return under notice. The total population,

including the Maoris and Morioris of the Chathams, was 39,805 persons—viz., 22,861 males and 19,132 females. The return of the Maori census in 1891 gave the population at 41,993. There is thus shown a decrease of the native population during the past five years of 2,188 persons, or 5·2 per cent. In other words, for every hundred Maoris living in the country in the year 1891 there were only 94·8 in April, 1896. It has been known for many years that the native population was decreasing, and, without the help of a census such as the Government has issued, those who have occasion to travel through native settlements can testify to the fact. When Sir George Grey addressed his despatch, No. 121, Legislative, to the Right Honourable Earl Grey, in August, 1851, with reference to the Provincial Councils Ordinance, he referred in the twelfth paragraph to the native race, and estimated them at "one hundred and twenty thousand souls," a very large proportion of whom were males capable of bearing arms. As Governor of the colony at that time, Sir George Grey had excellent opportunities of estimating the Maori population, and I have reason to think that the estimate he made was not an extravagant one. It would thus appear that in the short space of forty-five years, or in a single generation, the natives of New Zealand have decreased by no less than eighty thousand, or twice the present native population. In paragraph 11 of the despatch the total European population of New Zealand was estimated at twenty-six thousand, or little more than one-fifth of the native population, whilst the census in April last showed the European population to be 703,360, or about twenty-seven times what it was forty-five years ago, and seventeen and a third times that of the present native population. It is not necessary to point out here the marvellous physical and social changes that have taken place in both Islands during the same period, but it is a fact nevertheless that just as settlement has spread and free European intercourse has been allowed in what may be termed native districts there has been a decrease in the Maori population, whether the times have been warlike or peaceful. What has not been accomplished by means of the sword of the settler has been equally well accomplished by the Government of the country in its efforts to dress in European garb and make live in European ways the native aborigines, without one single thought as to adaptiveness to environment, especially upon a free, roaming, and warlike race.

It is to be regretted that the census return omits to set forth the number of children of the native race compared with the adult population, as this would have been of great value in enabling a comparison to be drawn between the two races—one dominant, aggressive, and adaptive; the other imitative,

subjective, and living under conditions that are unnatural, and such as no civilised Government would approve were the true aim of government to regulate and safeguard the well-being of the subjective race equally with the dominant one. The means of obtaining information on a matter of such importance are not difficult, such as they were a few years ago. In all the native centres schools have been established, and the teachers in them exercise a wide influence among the native population. The services of these teachers should be employed to obtain special information relating to the younger generation of the native race, just as is done in the case of teachers in the public schools, who are usually employed in the smaller centres of population as registrars of births, marriages, and deaths, and from whom the best information is always available.

The reports of the enumerators are suggestive and full of interest to those who desire to study the native race. From them it appears that vice and crime are diminishing in most of the native districts. Agricultural work is extending, and a good many natives appear to be devoting more attention to the raising of stock, whilst the opening of Native Land Courts is urged as detrimental to the spread of this work among the natives. At the time of taking the census the general health of the natives was good, although measles, influenza, fever, and other epidemic forms of sickness have raged among them in various places since 1891. Three of the enumerators make reference to the drinking habits of the people, and there is evidence to show that the moral influences which have been brought to bear upon the native race of late years are operating beneficially in many ways. Colonel Roberts, of Tauranga, one of the enumerators, says, "The Alcoholic Liquors Sale Control Act Amendment Act, passed last session, prohibiting the sale of liquor to female natives, is being carried out in a satisfactory manner, and the result is very marked as regards their general conduct and behaviour when contrasted with the past." Mr. Hutchison, S.M., of Mastorton, another enumerator, reports "that drunkenness is not a vice of the Wairarapa native"; whilst Mr. Kenny, sub-enumerator for Marlborough and the Sounds, says, "There appears to be a strong feeling among many Maoris in favour of the strict enforcement of the law prohibiting the sale of intoxicants to Maori women." "I am told," continues the enumerator, "that in Picton the Maori women can obtain drink without difficulty, but not, I understand, from the hotels." It is hard to say whether the natives as a race are a debt-laden people, but those who know them best are aware that little or no foresight is shown by them whenever they have money at their command. To satisfy the wants of to-day appears to be with them, as with

all half-civilised communities, the sole end of their existence; and yet the summary on pages 13 and 14 of the return shows that there are individuals among the Maori race who cultivate the soil with a view to profit and exchange: 9,000 acres of potatoes, 2,200 acres of wheat, 9,200 acres of maize, and 7,000 acres of other root-crops is no bad record of native industry for a single year. In addition, the natives had 66,000 acres of grain-sown lands, and they held in common more than 11,000 acres of cultivated lands for produce such as melons, marrows, and gourds of different kinds. Their flocks of sheep numbered 314,000, their cattle nearly 30,000, and their pigs over 50,000. With such possessions it can hardly be urged that a population of under forty thousand souls is badly off; and I doubt whether it would not be difficult to find such a satisfactory record among a half-civilised community in any other country that has been settled and governed in the same way as New Zealand.

The effect of confinement in prison on natives is specially referred to by Mr. G. H. Davies, another of the enumerators, and his remarks on this subject are interesting and valuable, as showing the effect such treatment has upon a people whose notions of duty and obedience are unlike those of the colonists, who have been brought up under a different environment. He says, "Confinement such as the native prisoners are subject to, while they have every possible care, kindness, and attention, causes them to grieve for freedom and droop. Imprisonment to them means more than it does to their white brethren—the product of modern civilisation—and should be taken into consideration when sentence is passed on them. It is not punishment in such a case, but the infliction of great cruelty. In dealing with problems affecting a race such as the Maori the influence of heredity should be considered. Knowing as we do what the ancestry of the Maori must have been—warlike, fearless, generous, hospitable, lovers of freedom, and living an untrammelled life—we should make allowance for those whose fathers, little more than fifty years ago, led a free life, and are now compelled to obey the laws which to them are so restrictive in their operation."

Sir George Grey, in the despatch already referred to, said of the Maoris, "They are fond of agriculture, take great pleasure in cattle and horses, like the sea and form good sailors; have now many coasting-vessels of their own manned by Maori crews; are attached to Europeans and admire their customs and manners; are extremely ambitious of rising in civilisation and of becoming skilled in European arts; they are apt at learning, in many respects extremely conscientious and observant of their word, are ambitious of honours, and are probably the most covetous race in the world. They are also agreeable in

manners, and attachments of a lasting character readily and frequently spring up between them and the Europeans. A great many of them have now from their property a large stake in the welfare of the country; one chief has, besides valuable property of various kinds, upwards of £500 invested in Government securities; several others also have sums of from £200 to £400 invested in the same securities."

I have made these quotations to show that even to-day the Maoris retain in great measure the character which was given them nearly half a century ago, although the interval has been passed in many sanguinary contests for supremacy between themselves and the colonists. Again and again have the natives suffered defeat and heavy loss, but the results have only shown the truth of Sir George Grey's estimate of them both in peace and in war. But, although the natives have usually shown themselves willing to listen to the advice of the Government of the colony, it is surprising that so little has been done on their behalf and with a view to their improvement and development. The whole history of the native race since the governorship of Sir George Grey to the present is one long period of mistakes, dissatisfaction, and misunderstanding. The natives have been compelled to recognise the authority of the white man at the point of the bayonet, not that the white man intended to force himself into the country in the way he has, but simply because the Maori desired to go his own way and pursue his own methods in his transactions with the white man. Throughout the long period of intercourse no attempt has been made to influence Maori life through Maori authority. The Queen's law was and is for settler and native alike, but nothing could have been more unnatural and unjust to the latter. The Queen's law was understood and realised by the colonists. We had come to know the meaning of obedience, authority, and protection, and the law, whilst it enacted obedience to authority, gave protection in a way that no native could possibly understand. "Warlike, fearless, hospitable, generous, lovers of freedom," such were the attributes of the Maori. When the arm of savage and civilised met in conflict the skill of the former was their only protection against a foe, and to expect the native to become amenable to a settled form of government such as that established by the colonists was both irrational and unjust from a native point of view. To those who study the causes that led to the war in the Waikato, or the growth of the Hauhau fanaticism, followed immediately by the Te Kooti raids, there is no difficulty in assigning all the troubles to the refusal to recognise what may be appropriately termed a form of local government among the natives themselves. As a people the natives, from the time when they were first brought into

contact with Europeans, have always had a high ideal of the capacity and power of the latter. Whatever was done by the colonists in the shape of government was attempted or imitated by the native chiefs with a view to the benefit of their own people. They were not the initiators of change, but they strove to imitate the acts of those whose sword they feared, and whom they recognised as superior to themselves. When the colonists, in 1835, formed among themselves, at Russell, in the Bay of Islands, a judicial and legislative Executive Council for the punishment of evil-doers, the principal natives of the North in the same year met and declared the independence of "The United Tribes of New Zealand." They decided to meet year by year for the making of laws and the due administration of justice among their own people, just as the colonists had decided a few months before. When the first meeting of the General Assembly took place in Auckland, in May, 1854, a ferment among the natives began, which culminated in the meeting of representative chiefs on Lake Taupo in 1856, when Te Wherowhero, from Waikato, was unanimously chosen by the assembled chiefs as native king, under the title of Potatau I. The aim of the representative chiefs was the control and government of the native race according to native law and custom. They fully recognised Her Majesty as their queen, and on a pole in the centre of the area where the meeting took place, and within a few yards of the lake, the English flag floated gaily, and below this were two others, one representing the Governor and the colonists and one representing King Potatau I. and the natives, both flags floating at the same elevation and of equal dignity and authority. From the signing of the Treaty of Waitangi, in 1840, no doubt appears to have been raised by the natives as to the fact of New Zealand being immediately subject to the British Crown, but they have always kept in view their right to local government and control. It is curious how time alters the notions of the colonists in relation to such matters. During the past few years the native claims to local government have been allowed, and representative meetings of rare interest and importance have been held in places like Gisborne, Hastings, and Taupo. These meetings are now held annually in various centres, and questions are discussed and dealt with in a way that would do credit to assemblies of larger pretensions.

During the past eighteen years I have had exceptional opportunities for studying the habits of the natives, and it seems to me the time has come when something should be done to stay, if possible, the disappearance of this fine and noble race of people. It has been explained what their characteristics were in 1851, and again at the beginning of the present year.

Their numbers have diminished, and are diminishing at a rapid rate, but in many respects their fine qualities remain. Their desire for war has gone, and the force and energy so characteristic of the older natives are only met with at rare intervals among the young generation of men. The arts so common among them, such as weaving, making nets, mats, &c., in the case of the women, polishing greenstone and carving among the men, will soon become things of the past. The younger folk know as little of Maori art such as it was a quarter of a century back as do the majority of the colonists; and even the raupo whare is giving way to the wooden house, although the latter is less comfortable, and certainly less warm, than the former. The native schools have greatly modified Maori ideas, but unless they are made more adaptive than now to the social and industrial needs of the race the work that is being done in them so well can only end in making the extinction of the native easier and more rapid than it is. Let the present condition—moral, social, mental, and industrial—of the Maori race be fully understood in comparison with our own. Their dwellings are not separated into rooms like those of the Europeans; the same room is occupied by all for sleeping purposes at night and for conversation during the day. Their habits are not regulated by sanitary laws, and there is no authority regulating the arrangement of a pa, the location of a whare, the disposal of offal, and the hundred other minute but essential matters in connection with the sanitation and general welfare of the people. Formerly the chief of a pa occupied a position of authority, but such a position is now merely nominal, especially in all that concerns dwellings, food, and social intercourse. The fighting chief has either disappeared or will soon do so, whilst the chief by descent has no executive authority, and exercises but little moral influence among those who come into daily contact with some of the lowest forms of colonial life such as one sees so often in the vicinity of native settlements.

It cannot be denied that a good deal of information is being obtained by the younger natives as to the way people should live who aim to adopt European ways. In schools like the native college at Te Aute the young people are trained and educated in a manner which shows the capacity of the native race to gather information on subjects like history, geography, and grammar, and even in classics and mathematics many of the youths and young men display considerable capacity. But when they have conformed to European ways for four or five years, and have acquired a fair English education, they go back to their own homes, where the conditions of life are so different from the life and associations of the school. What can such youths and young men do?

They are already at their meridian in social and intellectual development, and their setting when they return home is rapid and effective. I have no doubt whatever that every young person when quitting a native school would infinitely prefer to live the life such as he has lived during his school career; but where is the outlet, and what can such young people do to modify the conditions of the moral, social, and industrial life in the native settlements to which they severally belong? From personal experience I am aware that many young natives return to their homes from the boarding-schools imbued with the desire strong upon them to live good lives, and to modify in some way the unsatisfactory conditions which they know exist either in their own home or in the pa; but a few days' residence suffices to convince them of the hopelessness of their efforts. They cannot change the habits of their elders, and they perforce must conform to the ways of the whare; and the ways of the whare are certainly not the ways of native boarding-schools like those of Te Aute, Hukarere, and the Convent. Nor should it be forgotten that native settlements differ entirely from what colonists find existing in the smaller villages among their own people. The village is usually in touch with the nearest market town, and every colonial child, as he or she ages into youth and manhood or womanhood, holds the power within himself to win his way into the larger centres of population, where mind, skill, and industry are always in demand. The natives—young men and young women alike—return home from school at the close of their school career, and they are isolated entities among their fellow-natives in scholarship and general knowledge; but what is the value of all their scholarship at a time so important? For their knowledge there is not the slightest demand among the native people, and, just at a time when emulation should be fostered by expectations of advancement, there is nothing in the Maori life by which such emulation can be encouraged, for they are unable to advance a single step in a society which is without government or organization, and the result is indifference and disappointment. It is at this stage in the career of the young natives where the study of this great social question as it affects the native race should begin. The young colonist, when he quits the school to work in the wider school of the world, has a thousand places of honour within his grasp should he possess capacity and ambition; but the Maori, on leaving school, however capable he may be, passes into a community where organization is dead, and in which there is not a single place of trust open to him. Is it any wonder that intelligent natives, fresh from school, soon grow indifferent, and inquire one of another as to the use of the training they have undergone? They observe colonists

acting as teachers for the instruction of native children; colonists as ministers of religion preaching the gospel to natives; colonists as doctors attending to the necessities of the sick natives; colonists as lawyers pleading in Native Courts; and yet the prospects of the brightest among the natives are blighted and hopeless, for the reason that the State has made no provision whatever for the utilisation of their services. But we have reached a point in the history of the Maori race when their rights and their duties must be brought up for reconsideration. A national spirit must be aroused amongst them. The decadence of ambition, purpose, and influence is bringing about the destruction of the race, and something is wanted to counteract these influences at the present time if we wish them to continue as a people among us.

I have briefly touched on some points as affecting the well-being and continuance of the native race which call for attention and amendment. We must look upon the natives as something more than aborigines. They are fellow-citizens, powerful in mind and body, and capable of playing well their parts in the duties of life under conditions suited to their modified surroundings. No native can live without ambition, and ambition can only be aroused by increasing responsibilities and arousing worthy ideals possible of attainment. The scheme such as is suggested below may be incomplete, and by some it may be looked upon as Utopian, but it is one which the present condition of the native race requires to be adopted without delay. As the dominant race it is our duty to strive for the good of those from whom as colonists we have obtained so much. When the Maoris were untouched by European influence they were endowed with qualities which suggested great power and capacity to improve. Their lives were then fully adapted to their environment; but new conditions have arisen, and everything should be done by the ruling authority to assist the natives in that adaptation to modified environment without which they will disappear as a people and a race. There is no alternative. Little or nothing has been done to assist them in bringing about the needful change. The first step cannot come from the natives, because the end to be reached is government and organization such as the race do not possess. With the disappearance of more than 1 per cent. every year in the native population, such as the last native returns show to have taken place during the past five years, the end cannot be far off unless stayed by the adoption of rational and scientific means. If it is desired that the native race, with their past romantic history and associations, shall disappear from among us, there is no need to take warning, for the end is already assured and it will not be long in coming. But the time

can be indefinitely postponed. Adaptation to the modified environment is the remedy, and this is possible under a proper organization that admits of internal growth and expansion. The Maoris possess all the qualities that go to make a great people, but their contact with new conditions of living have modified their own ways and thoughts, and the two conditions are antagonistic. The savage and the civilised cannot dwell together. There will be a disappearance of the one or a merging in the direction of the stronger force, and this is what must take place in New Zealand. The trials through which the natives have passed since they have been in contact with a newer and a higher civilisation have in some measure prepared them for modification in their own mode of living. Organization is to them a necessity, and that organization must embrace what will bring about new aspirations and new hopes among the leaders as among the separate members of the native race. The martial spirit of the Maori is dead. It has been destroyed by the spread of the white people among them; and something is wanted in its place, so as to arouse the people to new activities and new aspirations. The suggestions which are given below are the result of long observation among the Maoris and a full consideration as to the best means of creating among them a national spirit different from that of old, but adapted to the new environment. The decadence of ambition, purpose, and influence is bringing about the destruction of the race. With a view to counteract this tendency, it is necessary to institute something which will arouse emulation by the presentation of ideals—moral, social, and mental—such as it is possible and desirable for the native race to strive to obtain. Let the natives be taught to realise that there is a prospect of social advancement in competition with their own people under a form of government suited to their present condition, and emulation will soon be aroused and progress assured. The natives need not vanish before the progressive ways of the white man if the latter chooses to assist the former in the work of preservation and development, and the following scheme suggests a way in which the thing can be done. The proposals may be thus summarised: First, the establishment of a system of government; second, the opening of cottage hospitals for nursing the sick in various centres, where native girls could be trained in the art of nursing and healing; third, the scheme of native education amended, and so arranged that pupil-teachers and assistants may be selected from among the native race; and fourth, a system of scholarships established to enable the young men and women to proceed to the technical schools or the university for the specialisation of their studies with a view to work among their own people.

These four proposals constitute the basis on which an organized society among the Maori race can be built up. They contain within them the foundation of government, the recognition of authority, and the reward of industry and right conduct. The aim of the first proposal is to arouse interest among the natives themselves in their own well-being. Attention to everything that goes to improve the conditions of family or social life is the first need among the Maoris at the present time, and should tend to the physical, social, and moral advancement of the people, such as—(1) The regulation of buildings; (2) sanitation; (3) power to act in case of epidemics or local forms of sickness; (4) regulation of stores; and (5) regulation of accommodation-houses and places of amusement. A Board or duly-constituted governing authority possessing powers for the enforcement of regulations embracing the above matters would at once create interest and arouse sympathy. The work of the Board would be directive in its tendency, and, whatever defects might appear, it is certain that an attempt at an organized scheme of internal government would be beneficial to the natives physically, mentally, morally, and pecuniarily. As to the second proposal, I am satisfied that no one who has ever seen and visited the sick in some of the native pas but must have pitied the race and wondered why so little is done to ameliorate their sufferings. Living in isolated settlements and away from Europeans, many natives succumb in time of sickness simply for the want of a few small comforts and attentive nursing. Lives are needlessly wasted; and were cottage hospitals built in the more-important centres of the native population a great Maori need would be supplied. A hospital such as is suggested could be built at a very small cost, and it should be placed in charge of a properly-trained hospital nurse. Each hospital should be in telephonic communication with one of the larger centres where doctors reside, so as to facilitate inquiry in case of need. These hospitals would provide an excellent training-ground for the senior native girls from the schools, where they might also receive instruction in the preparation of foods both for those who are sick and, under certain conditions, for the benefit of the native women. The establishment of local government and hospitals bears directly upon the adult population. Emulation in this direction is necessary, and the conferring of power upon those of influence would produce highly-beneficial results. The old power of the native chief has been slowly passing away, and it is very desirable to reinstate him in a new seat of dignity by conferring upon him powers and responsibilities which, though differing from those he formerly held, would enable him nevertheless to resume that position among

his tribe that he has nearly lost by the modified environment. The third proposal makes provision for an outlet to those who have received an education at schools like Te Aute, St. Stephen's, &c. The employment of young men and women in native schools is a desirable and proper course to adopt. On the completion of their school career they should be permitted to attend public schools like Napier and Gisborne along the East Coast district, and Wellington, Wanganui, and New Plymouth on the south and west, and their training should be regulated by the inspectors of schools in the several districts. A six months' course of training would suffice to prepare the young people for employment as pupil-teachers in native schools. The same effects may be expected from the adoption of this plan as are met with in the case of pupil-teachers in the public schools who are trained as masters and mistresses. All the native young men and women who are trained away from their own homes realise the advantages of a modified form of civilisation for their own people, and they would gladly see an improvement in the home conditions of families such as now exist. Were provision made for the maintenance of such pupil-teachers in places away from their own homes, a knowledge that their position and advancement depended upon their attention to duty would be a sufficient inducement to perform their work to the satisfaction of the governing authorities. Many of the young men who have been trained in that excellent institution at Te Aute, established for the benefit of natives by Archdeacon Samuel Williams, are imbued with a strong desire to work for the social and moral improvement of their race, and should the way be opened on the lines here suggested we may look for great things in the way of Maori improvement and progress. The fourth suggestion bears directly upon the anticipatory work of the younger natives. If the younger generation is to prosper, there must be channels opened to them in anticipation of their entrance into life. It is for this reason that the establishment of special scholarships is proposed. Mr. R. D. D. McLean, M.H.R., in honour of his father, the late Sir Donald McLean, has established what are known as "Te Makarini Scholarships," by means of which younger natives can pursue their studies at Te Aute College, and from thence they can proceed to one of the university colleges to complete their education. Much good is being done in this way, and, were the number of scholarships increased by the Government, specialisation in the training could proceed in such manner that in a few years the native race would have their own supply of lawyers, ministers, teachers, and doctors. Local organization and government would soon be strengthened by the influence of such persons, whose habits

will have been modified by association and contact with the higher civilisation, and the continuity of race will be assured.

The suggestions which have been briefly outlined here may appear of little moment in face of the fact that the native race is slowly passing away; but the cure has been pointed out equally with the cause, and it remains for those who are intrusted with the oversight of the native race in this country to see whether the recommendations are worthy of consideration and adoption before it is too late.

Art. XI.—*On the Poua and Other Extinct Birds of the Chatham Islands.*

By Taylor White.

[*Read before the Hawke's Bay Philosophical Institute, 12th October, 1896.*]

In this paper I will endeavour to prove that the large, mythical, and extinct bird the poua, traditionally spoken of by the remaining survivors of the Moriori people who inhabit the Chatham Islands, was not allied to the moa (*Dinornithidæ*), but was a species of swan, and belonged to the family *Anatidæ*. Up to this date I believe it is correct to state that no find of moa-bones has been made at the Chathams, so we have no warrant to assume that the poua was a moa. Some persons have suggested that the fabulous bird of the southern Maori, the pouakai, might be similar to, or of the same species as, the poua, and it has been asserted that the former bird was a large eagle or bird of prey.

Assuming that the poua was a swan, its history might be related thus: It was a large bird of aquatic habits, whose favourite resort was the waters of Te Whanga (the harbour?), a large sheet of water separated from the sea by a sand-bank. Periodically this inland water gains a volume which causes it to burst through the shingle-bank and connect itself with the sea, until, by the shingle-bank being again cast up by the sea, this brief connection is dissolved. This poua (or swan) consumed great quantities of a plant which possibly was similar to that which we name duck-weed, and which floated in great profusion on the waters of this lagoon, and was called by the Moriori, "koko" ("koko?" is the name given by Mr. H. O. Forbes).

In the autumn season most, if not all, of the *Anatidæ*

(geese) are moulting, and often lose the pen-feathers of the wing preparatory to the formation of a new growth, and so are unable to fly. At this time also the young, although they have reached their full development, and are very fat, are still incapable of flight, for the feathers of the wing are the last to be produced.

All the young and many of the old birds being now unable to fly, this is the time when they are comparatively helpless, swimming and diving being their only means of defence. This is the most favourable opportunity for the Moriori to catch the swan. How should this be carried out? We will suppose a small bay in Te Whanga, having shallow water some 3ft. in depth, is selected and enclosed by a picket-fence formed of upright stakes driven into the mud, and which yard has a narrow entrance facing the lagoon, from either side of which an extending wing-fence is carried out to a considerable distance, to act as a lead to the entrance of the corral, for the trap or decoy is on the same lines as a stockyard for wild cattle, and is now complete. The battue now commences by a quiet and cautious surrounding of a flock of swans by the natives in a number of raft-canoes (for there is no timber here of size sufficient to form the ordinary dug-out or canoe), and the birds are gently driven forward in the direction of the decoy, great care being taken not to flurry or approach too closely to the birds, in case they might commence diving, and escape in all directions. The drivers gradually close in as the birds enter between the wings, and, as they are then in shallow water, it is an easy matter to cause them to go through the narrow entrance of the corral, or yard, which can then be built up with similar stakes already prepared for this purpose. The swans being now securely penned, their captors enter with clubs and quickly knock them on the head, for the shallowness of the water gives little opportunity for diving as a means of prolonging the hunt. Now the Moriori will make the usual preparations for a great feast.

I think the late Mr. Potts published an account of the poua which he obtained from the surviving natives of the Chathams, but of this I have no present remembrance; but I can quote from a very interesting paper by Mr. Henry O. Forbes, one time curator of the Museum at Christchurch, New Zealand, and published in the *Fortnightly Review* for May, 1893, page 669, and entitled "The Chatham Islands and their Story." Mr. Forbes says:—

"I knew from various sources that the Morioris had a tradition of a great bird they called the pouwa. Mr. Shand also had, with much kindness and trouble, recounted to me all that they themselves knew, and described to me the exact localities where they say their fathers trapped and killed

those wonderful birds. To these places, therefore, excursions were next undertaken, in great hope and expectation of success.

"One of the most striking features of Wharekauri" (the larger of the Chatham Islands) "is the number of tarns and lakes it possesses. The most extensive of these, named Te Whanga, occupies the greater part of the low central region of the island, and on its eastern side is separated from the sea only by a very narrow bar of sand, which every few years, when the lagoon becomes surcharged by the rivers which feed it, is carried away, and the water rushes out till the lagoon attains a certain level, when the sea again silts up the opening. The western side of this lake is bounded by cliffs of limestone of Palæozoic age, on which lies a bed, in some places 50ft. to 60ft. deep, of friable polyzoa, containing sharks' teeth and echinoderm spines of species belonging to the transition period between the Secondary and Tertiary epochs (the Cretaceo-tertiary of the New Zealand Geological Survey Reports). *Along the margin of this lagoon*, and at a short distance from the shore" (*i.e.*, of the lagoon, not the sea), "so the traditions run, the Morioris dug deep holes, into which the poüwa were driven, and, when inextricably bogged, they were clubbed to death, and then dragged ashore to the cooking-pits. At every one of the indicated places we succeeded in finding old ovens, the sites of camps, or the remains of feasts, which were, as usual, birds, molluscs, and fishes.

"At one spot at least we found grim proofs that the feasters did not always confine themselves to the aforementioned diet, for I gathered several human limb-bones and a couple of grinning crania, with in each an ominously suggestive hole in that region of the skull where an additional eye would have proved of such inestimable advantage to a race so cruel and treacherous to each other as our own. To my great disappointment, our extended excavations rewarded me with no bone or fragment of a bone of the poüwa or of the *Apteryx*. Yet from circumstantiality of the account of the poüwa in their traditions, and of the narrative I listened to a little later from Tapu, one of the oldest surviving chief men of the Morioris (whom I found living in a poor house-cluster at the south-east corner of the island), I cannot resist the conviction that the poüwa, which, if it was anything, must have been a species of moa, did actually live on these islands.

"Tapu was an intelligent old fellow, with a very Jewish countenance and highly-developed frontal processes. 'The poüwa,' he said, 'he a big bird; he die—Oo!—two hundred, three hundred year'"—(this estimate of time is an acquired

European phrase)—" 'long time ago. I see his bone stick up in Te Whanga, where the Morioris camp long time back. Me young fellow; father of me tell me Moriori make him hole in water, drive him poüwa in, hammer him dead, and roast him. His bone I see him stick in hole in mud in lagoon water. Oo! big, all same as cow; *he eat plenty grass*, swim'" (floating on) " '*lagoon water;* Moriori call "koko." '* It is, of course, impossible to describe in words Tapu's gestures and expressions, but no one who heard him could doubt that he had seen large bones in the lagoon, and that their origin had been explained to him by his father.

"In the kitchenmidden that produced the human remains *there were thousands of swan-bones* of the same species as that I had gathered by the side of the oven on *the Waitangi Beach. This lake was therefore, probably, their chief home*, whither they must have resorted in *enormous numbers*, for in some localities they appear to have been *almost the sole food of the people*. That the swan, now indigenous only to Western Australia, South America, and the north of the Northern Hemisphere, had in past times been also a native of New Zealand was unknown till the previous year, when it was discovered during my excavations of a cave near Christchurch. . . . The Maori fisher-folk who occupied the cave fed on the swan and on the moa, and cast their bones side by side into the refuse-heap in front of their door, to await the future.

"Within recent years the Australian black-swan (*Chenopis atrata*) has been introduced into New Zealand, and has already multiplied with extraordinary rapidity. . . . The cause of the total extinction, therefore, of the ancient swan (and other birds also) in its natural home appears at present inexplicable."

May not the poua have had weak pinions similar to the flightless duck of the Auckland Islands and the steamer-duck of the Patagonian coast?

We will now note the account of certain extinct or unknown birds of the Chathams, mentioned by Mr. Shand in his account of "The Moriori People of the Chatham Islands," published in the Journal of the Polynesian Society, vol. iii., p. 80:—

"The mehonui, a species of the New Zealand kakapo (*Stringops habroptilus*) *larger than a goose*, and the mehoriki, a bird about the size of a small hen. Both are extinct; they were wingless birds. The mehonui" (*i.e.*, large meho) "was usually captured on its sleeping-place or nest, where six or

* Mr. Forbes must have here given a wrong name for this water-weed; "koko" is the name given to the bird tui, the parson-bird (*Prosthemadera novæ-zealandiæ*), by the Moriori, and also used by the Maori in the south of New Zealand.

eight might be found huddled together, as the Morioris declare, like pigs in a bed. Having by observation found its sleeping-place on the 'clears,' the Morioris made long tracks leading up to it, carefully removing any sticks or obstructions which might alarm the bird by cracking; and then, by making a stealthy rush, they pounced on them, and secured all in the nest or sleeping-place. This bird had a powerful strident call, which could be heard at a great distance. *Its neck was said to have been about as long as a man's arm.*

"The mehonui was peculiar in this: that if any one approached it in front it did not see him, and, approached thus quietly, was caught by the neck and strangled. It kept its head continually on the ground, looking for food, chiefly fern-root, which it burrowed for and dug out with its powerful bill, making, it is said, a rooting like a pig. Any one, however, coming from the side or behind was quickly detected, and the birds made off. Its colour was reddish-brown, something like the New Zealand kaka. The mehoriki" (small meho) "was a very tame bird, *but was only caught at certain seasons*, being strictly preserved at others. *The eggs were never eaten if in the least turned*" (*i.e.*, sat upon); "children were always reproved for so doing. *The birds were caught by preparing large traps with wide wings to them, between which they were quickly driven.* These birds lived in and preferred the undergrowth of the bush, which afforded them concealment." (Rather difficult to round them up in such a place.) "The flesh was said to be very delicate, and much relished by sick persons. The mehoriki was a very watchful bird. No stranger could approach without it uttering its warning cry." (This is a singular habit for a very tame bird.) "In colour it was light-straw-coloured, and spotted like the New Zealand bittern, but not so dull a grey as the latter. The eggs were spotted, and about the size of a medium or small hen's egg.

"They also had the pakura (*Porphyrio melanotus*). There were also several varieties of ducks—*perer'*, which were snared in pools or ponds, or *driven ashore in the moulting season* (*perer' mounu*). *They were driven from the lagoons into the rushes and coarse growth of the 'clears' or open land, where large numbers were caught.*"

It seems to me that the habits and descriptions of these birds have got mixed up. The parts I have written in italics would seem applicable to the extinct swan and the method of catching it. The mehonui could not well be the name of a species of kaka-po (*i.e.*, night-parrot), nor would a parrot have a neck as long as a man's arm; for the Polynesians signify a parrot by the word "kaka"; like the Maori kaka (*Nestor meridionalis*), kaka-riki, "small parrot" (the varieties of the

parrakeet, *Platycercus novæ-zealandiæ*, &c.)* And this word "kaka" is said to be found in our English name "cockatoo," from the Malay kaka-tua (or tuwha), and comes to us through the Portuguese. Moreover, Dieffenbach visited the Chathams in 1839–41, and obtained a specimen of a nearly extinct rail, of small size (*Cabalus dieffenbachii*), the native name of which he gives as moe-riki—*i.e.*, "the small moe" (not meho, but evidently the same word, for Mr. Shand mentions no rail to correspond with this otherwise); and in New Zealand "moho" is the name of a species of flightless rail or coot, also called "takehe" (*Notornis mantelli*), a bird larger than the pukeko (*Porphyrio melanotus*) but of similar-coloured plumage and markings; and in Maori "moho" is the name for dark-blue colour, as if the bird's plumage was taken as the standard of that colour, and Dieffenbach's rail is not of that colour. Forbes found the remains of a large coot, or waterhen, at the Chathams, which he supposes almost identical with similar remains found in far-away Mauritius (*Fulica newtoni*); also the bones of a large rail (*Aphanapteryx*); a raven-like crow (*Palæocorax moriorum*); the kea (or mountain-parrot of New Zealand), so named from its call-note by the Maori, and not "kaka" something, by the rule laid down above (*Nestor notabilis*); the lesser owl (*Spiloglaux novæ-zealandiæ*); the small hawk (*Harpa ferox*); and of the woodhen, or weka (*Ocydromus australis*): "they lay in association with Dieffenbach's woodhen (*Cabalus dieffenbachii*), a bird so rare that since 1840 only three specimens have been obtained." Bones of the tuatara lizard (*Sphenodon punctatum*) were also obtained.

In New Zealand there was at one time, and it was known to the early colonists, a small rail, the banded rail (*Rallus philippensis*), considered identical with a rail found at the Philippine Islands. It was called moho-tatai, moho-pa-tatai, and moho-pereru: "tatai," the sea-coast, on the "moho," of the seashore.

Mr. Shand's description, given above, of the method adopted in catching the meho-nui (or large meho) or moho, is singularly borne out or corroborated by the verbal form of moho in the Maori language—as, whaka-moho, "to steal softly upon any one"; and to this we might compare whaka-kiwi, "to look aside, to regard obliquely." No doubt this was a habit of the kiwi (*Apteryx*) when listening for the movement of worms or underground insects. A place near Wanganui called Ara-

* The parrakeet provided the standard of the colour green to the Maori, so kaka-riki = green, also a green lizard (*Naultinus elegans*); and New Zealand has another parrot form in the kaka-tara-po or kaka-po (night-parrot), the flightless parrot (*Stringops habroptilus*). It is possible that the kea, or keha, the sheep-eating parrot, was originally named kaka-kea.

moho—" the road or track of the moho (*Notornis*)—shows that the Maori was well acquainted with this bird.

Mr. Edward Tregear, in his Maori-Polynesian Dictionary, gives—

"Poua (myth.), a gigantic bird, said to have inhabited the Chatham Islands. The last flock is reported to have been drowned in the large lagoon called Te Whanga, they having been driven into it by the natives. There is as yet no proof of their having existed. The poua is probably related to pouakai, which see."

"Pouakai (myth.), a man-devouring bird of gigantic size, supposed to inhabit the South Island (of New Zealand). One of these birds was a source of terror to the fairies, called Nuku-mai-tore, until Pungarehu smashed its beak with his stone axe and killed it. See "Ancient History of the Maori," by John White, vol. ii, p. 33. For tradition of one being killed by Te-hau-o-tawera, see A.H.M., iii., 194; also see Stack, Trans N.Z. Inst, x., 63."

I hope my readers will agree with me that my argument fairly proves that the poua was a swan, and that the finding of thousands of the bones of this bird by Mr. Forbes at the very spot pointed out as the place where the poua was most readily killed verifies the same; also, that the mehonui could not be related to the parrots, but was most probably allied to the *Notornis*, more especially on the strength of the term "whaka-moho" (to approach stealthily), and of the word "moho" also meaning in Maori "a stupid, a blockhead"—possibly alluding to the ease with which the bird might be caught. It is just possible that *Aphanapteryx* was the large meho, and the coot, or waterhen, was the lesser meho. What, then, was the name of the smaller rails—moe-riki (*Cabalus dieffenbachii*) and the one lately described by the Hon. W. Rothschild? It is quite certain the smaller rails would be active and hard to find, as they are found to be at this present time, even setting aside the fact of their great rarity. Yet Mr. Forbes found the bones of *Aphanapteryx*, a large rail, of a coot (*Fulica*), of the woodhen (*Ocydromus*), and of Dieffenbach's rail (*Cabalus*) at the same refuse-heap, which would give us three rails, including the woodhen. This would give three species to compete for the two names, "meho-nui" and "meho-riki."

Although this paper has been written in haste, and under difficulties, I hope that a fair amount of proof is given to show the great probability that the great bird poua was the extinct swan.

ART. XII.—*Notes from Murihiku.*

By A. HAMILTON.

[*Read before the Otago Institute, 9th June, 1896.*]

Plates VI.–X.

ON SOME PAINTINGS ON THE WALLS OF ROCK-SHELTERS IN THE WAITAKI VALLEY.

IN America, in Australia, and in many countries of the Old World there are found occasionally, in suitable places, figures or symbols—painted, cut, or scratched—representing usually men or animals, sometimes symbols or marks which can in some cases be ascertained to have a definite meaning, or, at any rate, to correspond very closely with those whose meaning is either definitely or generally known.

In Australia a great number of carvings, paintings, and sculptures, made by the aborigines, have recently been described, and evidence has been adduced that the custom of making symbols or records on rock-surfaces has been prevalent down to the present time For many years after the settlement of Australia little was known of the rock-records of the natives. The first to call attention to them was that observant navigator Captain Cook, and, later, Governor Phillip, Surgeon White, Captain Tench, Flinders, and the officers of the first Government on the establishment of the Colony of New South Wales. They were followed by Mitchell, Sir George Grey, and subsequently Leichhardt, and other explorers of the interior have pointed out paintings and carvings over a very wide field. A wondrous halo of romance and mystery lies over these mystic signs, for the scanty tradition of the Australian races throws no light on them. The problem of the origin of many of these paintings is a matter of great interest, and is attracting much attention.

It should not be forgotten that in the southern portion of the South Island, in the district or area formerly known to the Maoris as Murihiku, there are a considerable number of rock-pictographs quite equal in interest to those of either America or Australia. The late Professor Von Haast described in several papers before the New Zealand Institute, and other societies, the rock-paintings at the Weka Pass, and thereby raised a considerable amount of controversy. There are other series of rock-pictographs in several places in the Canterbury District—on the Tengawai River, and other limestone dis-

tricts where there are caves or rock-shelters. Having spent most of the years that I have been in New Zealand in the North Island, I had never had an opportunity of seeing any of the pictographs of the kind described by Professor Von Haast until quite recently. Since the close of our last session I paid a visit to Duntroon, a small township on the Waitaki River, for the purpose of photographing the pictographs casually mentioned by the late Hon. W. B. D. Mantell in his address to the Wellington Philosophical Society on the moa, on the 19th September, 1868, published in the first volume of the Transactions. In that volume is given, on plate vii., a representation of a few of the pictographs, and amongst them one which Mr. Mantell took to be a moa feeding. Unfortunately, the address is only given in abstract, so that we cannot tell exactly what the lecturer said on the subject of these Ngatimamoe or Rapuwai works of art. The Takiroa cave or shelter is close to the road and the railway passing up the Waitaki Valley, and is the result of the usual aërial agencies acting on a limestone bluff in the river-bed. The photographs which I exhibit show that the cliffs are of a considerable height, and have a talus slope down to the level of the road of the fragments detached by the constant action of the wind and rain. The position of the cave is sunny, and, although a strong wind was blowing down the valley, I found the cave itself well protected from its violence.

On my first visit I carefully examined the walls of the rock-shelter, and found that the figures were easily divided into three classes—First, those painted on the surface of the rock with a thick medium of animal fat or oil in black or red (*kokowai*), those in black (charcoal?) being apparently the earlier. Secondly, by figures drawn in black without any medium at all, probably with a charred stick or piece of charcoal: these can easily be distinguished from the earlier ones, and careful rubbing will remove them, but has no effect on the others. Thirdly, there are a few initials and marks cut in with knives by the modern vandals or travelling swaggers—to say nothing of one ingenious man who has painted his name in a conspicuous position in orthodox oil-paint.

I took a series of photographs of all the black and red pictographs, and I have since had them enlarged considerably, and I intend taking these enlargements to the spot and colouring them from the actual paintings. In this way I hope to eliminate as far as possible the "personal equation" which disturbs so largely sketches made by even practised artists.

Professor Von Haast, in his paper, described elaborately the different figures from the Weka Pass, and laboured earnestly to invest them with mystic meanings, seeing therein altars and Tamil characters. Now, the figures that I saw at the Takiroa

Cave do not strike me as requiring to be interpreted by the imagination of the observer.

The officers of the American Bureau of Ethnology have recently published an enormous volume full of pictographs from the three Americas and other parts of the world, and these are some of their general conclusions: "The most important lesson to be learnt from these studies is that no attempt should be made at symbolical interpretation unless the symbolical nature of the particular character under examination is known, or can be logically inferred from independent facts. To start with a theory, or even an hypothesis, that the rock-writings are all symbolical, and may be interpreted by the imagination of the observer, or by translations either from or into known symbols of similar form found in other regions, were a limitless delusion. Doubtless many of the characters are genuine symbols or emblems, and some have been ascertained to be such. Specially convenient places for halting and resting on a journey, either by land or water, generally exhibit petroglyphs if rocks of proper character are favourably situated there. The markings may be mere idle scrawls or the result of more serious intention. Some points may be ascertained with regard to the motives of the painters and sculptors on rocks. Some of the characters were mere records of the visits of individuals to important springs or to fords on regularly-established trails. In this practice there may have been, in the intention of the natives, very much the same spirit which induces the civilised (?) man to record his name or initials upon objects in the neighbourhood of places of public resort. But there was real utility in the Indian practice, which more nearly approached the signatures in a visitors'-book at an hotel or public building—both to establish the identity of the traveller and to give the news to his friends of his presence and passage."

The work* shows a surprising resemblance between the typical form among the petroglyphs found in Brazil, Venezuela, Peru, Guiana, part of Mexico, the Pacific slope of North America, and even Japan and New Zealand. Interest has been felt in pictographs because it has been supposed that if interpreted they would furnish records of vanished peoples or races. All suggestions of this kind should be at once abandoned. The practice of pictography does not belong to civilisation, and declines when an alphabet becomes popularly known. Though the figures found do not disclose the kind of information hoped for by some enthusiasts, they surely are valuable as marking the steps in human evolution, and in presenting evidences of man's early practices. It is not denied

* "Picture-writings of the American Indians." Garrick Mallery: Rep. Bureau Ethnol., 1888–89.

that some of the drawings on rocks were made without special purpose, for mere pastime, but they are of importance even as scribbles. The character of the drawings and the mode of their execution tell something of their makers. If they do not tell us who those authors were, they at least suggest what kind of people they were as regards art, customs, and sometimes religious belief.

But there is a broader mode of estimating the quality of known pictographs. Musicians are eloquent in lauding the great composers of songs without words. The ideography, which is the prominent feature of picture-writing, displays both primordially and practically the higher and purer concept of thought without sounds.

Having examined the walls of the rock-shelter, I easily recognised the figures given on plate vii. of the first volume of the "Transactions of the New Zealand Institute." The top figure on the right hand is figured as extending upwards in a series of dots. I was much interested to find that these dots are not part of the original figure, which is a very old one in red, painted with a fatty medium, but is, in reality, a charge of lead shot which has been fired into the rock at close quarters, as the shot are grouped together. Many of the shot still remain more or less imbedded in the face of the rock, which in this part has the hardened somewhat glassy surface which occasionally forms on a limestone face. Now, the figures drawn so accurately by Mr. Mantell were made in 1848, when he was travelling up the "River Dismal," so that for nearly fifty years those shot have been sticking in that thin coating on the face of that rock. This is evidence that there has been very little change in the surface of that part of the shelter.

Being so close to the road, the rock-shelter has been frequently used by travellers passing up and down the valley, and their presence was attested by an examination of the floor of the shelter, in which I was most kindly assisted by several local residents. Beneath the surface-sand which covers the floor was a layer of fine rushes and grass, which had been cut on the neighbouring river-bed for sleeping purposes; tent-pegs and fragments of canvas were also found, together with a tin match-box and some buttons. Below this layer, and nearer to the wall of the shelter, was a thin layer of decayed vegetable matter, with some flax matting of a very coarse character, and very much perished. Great numbers of birds' feathers were met with between these two layers of bedding—mainly feathers of weka, quail, a large seabird (albatros?), paradise-duck, and shag. A large number of bones of the now extinct New Zealand quail, including twelve sterna, were recovered, and in the deep sand at the

Duntroon end I found a very perfect moa-feather, quite black—quite a new colour in moa-feathers. In different parts of the Maori level were found the following items: A tooth of the sea-leopard seal (*Stenorhynchus*); the whole of the natural surface had been polished off, and the fang-end rubbed thin to permit of the hole being bored in it: three fragments of bird-bone worked down to a sharp point: several cut pieces of *Haliotis* shell and three valves of *Mytilus*, the latter probably for preparing flax, the former for carrying paint in for the adornment of carvings or weapons: a few small lumps of red oxide of iron (*kokowai*): a few small *Patellas* and some valves of the small *Unio* from the neighbouring river: several (five) small thin sticks, about 5in. long, with thin strips of flax-leaf tied on to them in a peculiar knot, probably parts of bird-snares: four small chert flakes, with sharp edges.

I was not able to examine the talus slope by making a cross-section through it, as I should have liked to have done.

From the character of the part of the floor I examined it appears to have been used as a temporary resting-place for parties travelling up and down the river.

The only special note that I made about the paintings was that one very long figure was executed on a portion of the rock quite close to the present surface, and it appears that that portion of the shelter must have had the floor at a lower level when the figure was painted.

Reaching Duntroon in the evening, I went for a stroll to the limestone cliffs on the Maerewhenua, just where it touches the railway, and there I found a number of other pictographs, some having the appearance of great age, and others in a cave some distance up the cliff very fresh and vivid. Those on the lower level near the road have been nearly obliterated by smoke and time, but those in the higher cave have been disfigured by Europeans. I made sketches only of these, as I had used all my photographic plates on the Takiroa ones. The figures occur in various places on the cliffs, and there is one at the very end of the cliff towards Oamaru.

A road passed just in front of the great shelter-cave, which is about 120 yards long, and the process of cutting the ditches for draining it has made a convenient section of the talus slope in front of the shelter. I was pleased to find many moa-bones and broken and cut fragments of moa-bone, and was fortunate enough to pick out from the bank a well-made bone fishhook-barb, dropped or lost—who shall say how long ago? I believe that a systematic exploration of this cave and the bank in front would yield interesting results. For many years the cave has been used as a place for storing old reapers-and-binders and worn-out machines, and for a shelter for horses.

In the Maerewhenua Creek I noticed a very prevalent form in the stones, which would render it an easy matter to manufacture from a well-selected sample a stone *mere* of the form we frequently see in Otago, and Otago only. I give a sketch of two stone clubs of this form found in the vicinity (Plate VIII., figs. 3 and 4); they are remarkable for having the perforated hole in a most unusual position.

Before leaving the subject of the pictographs, I may say that a fragment of a map made by an old Maori—Te Warekorari—for Mr. Mantell, in 1848, shows several localities in which sculptured and painted rocks are to be found up the Waitaki, and I am making inquiries through some friends in the district to identify these spots.

Discovery of a Maori Kete at Upper Taieri.

Through the courtesy of Mr. W. G. Rutherfurd, of Rugged Ridges, I was enabled to examine a very interesting Maori *kete*, or basket, containing a number of articles of interest, which had been found in a small cave formed by an overhanging rock on the Puketoi Station, Patearoa, Upper Taieri, by Mr. D. M. Wright. The *kete* was a large one, laced up with a long attached cord, which passed alternately through the small loops on the opposite sides in the usual way, and was in excellent condition, the cave being clean and dry. The contents were as follows:—

(1.) Several bundles of dressed flax (*whitau*), in hanks (*whenu*). Two of the bundles were stained a beautiful black colour (*parapara*).

(2.) Two small mats, just commenced (*kakahu*).

(3.) A very large *Haliotis* shell (*paua*), which had a beautiful plaited-flax handle worked on to it, passing through the natural holes in the shell. The shell was still full of red paint, and a piece of an old mat soaked in the paint was in it to serve as a brush. The red paint would be either applied to the person or to the buildings or ornaments of a chief. There was a smaller *paua* shell not used.

(4.) Two bones from the wings of an albatros, cut off neatly at each end, and prepared for flutes; the holes, however, were not bored.

(5.) Several pieces of dogskin: one piece cut into strips for a chief's mat; colour, reddish-brown and white.

(6.) A bag about 10in. by 6in., beautifully made in several patterns, a long flax cord attached to the upper part. The bag was made of very thin strips of some leaf, and the Puketeraki natives at once recognised it as a kind called *pukoro*, this being the name for a particular kind of bag into which the fruit of the *tutu* (*Coriaria*) is put, and the juice expressed

through the interstices. I know of no other example of this. The bag itself was half-full of *kokowai*.

(7.) Another very small bag of flax(?) fibre, made in a peculiar way; about 5in. long. Inside this little bag or sachet was a piece of *mimiha*, a kind of pitch picked up occasionally on the beaches in Otago, and which was used by the natives as a masticatory. In the North it was known as *kauri tawhiti*.

(8.) Two pairs of sandals (*paraerae*), made from the plaited leaves of the cabbage-tree (*Cordyline*). One pair was quite new and single-soled (*takitahi*); the other pair had been worn, and were much thicker, being double-soled (*torua*).

(9.) Several large bundles of the tomentum stripped from the back of the large alpine *Celmisia* (*tikumu*). This was worked into warm and handsome mats.*

(10.) A small parcel of a sticky-leafed *Celmisia* (*C. viscosa*). These leaves have a very pleasant smell, and were probably gathered for the viscid sweet-smelling gum (*hakeke*). There was also a small packet of the fragrant gum of the *Pittosporum*.

(11.) A hank of twisted flax-threads, for mat-making (*aho*).

(12.) Fragment of a whitebait-net made of flax.

(13.) Small bundle of the vascular part of the cabbage-tree stem or root (*kauru*).

(14.) Small bunch of albatros-feathers.

(15.) Feathers of the *kakapo*.

(16.) Several *Mytilus* shells, which had been used for scraping and preparing the flax.

The *kete* thus contained, probably, the treasures of some industrious old Maori lady who had been up to the alpine country to collect the *Celmisia* tomentum for a mat for her lord and master. She had likewise collected some sweet-smelling gums, to be hung in a small sachet round her neck; and possibly the other articles were taken with her as fancy-work to occupy the hours of a wet day, when she did not feel inclined to travel. There were three very fine specimens in this find—the shell with the flax handle or loop for suspension, the bag for straining the juice of the *tutu*, and the little bag or sachet for the masticatory.

DISCOVERY OF SOME SAMOAN(?) MATS AT HYDE, CENTRAL OTAGO.

In August, 1894, Mr. Matthewson found in a small rock-

* "At one particular place (near Mount Egmont) we met with a substance that appeared like a kid's skin, but it had so weak a texture that we concluded it was not leather, and were afterwards informed by the natives that it was gathered from some plant called *teegoomme*. One of them had a garment made of it, which looked like their rug-cloaks."—Parkinson: "Journal of a Voyage to the South Seas," p. 115, ed. 1773.

shelter near a waterfall, about four miles and a half from Hyde, the following things :—

(1.) A *kete*, or bag, with a folding flap like the flap of an envelope, with a cord at the point of the flap of plaited fibre 8ft. long to wind round the bag as a fastening. The bag is about 15in. across and 8in. in depth, with the upper edges neatly finished. The surface is ornamented with three brown longitudinal lines about 1in. wide. The flap is ornamented in the same manner, but in the other direction. There is no join in any part, the whole being woven in one piece.

(2.) Inside this were two very large hanks of fine cord, as even as if made by the best salmon-line maker. I should think there would be 700 or 800 yards in the whole lot. Each hank was about 2ft. long.

Next was a piece of very soft white tappa-cloth, 6ft. long and 18in. wide at one end, tapering to a point; also an irregular strand of lace-bark, about 5ft. long.

The next thing was a strip of woven matting, 8in. wide and 7ft. long, of evenly-woven strips a little more than $\frac{1}{16}$in. wide. One side of this is dull and the other side bright-yellow, the material still retaining the cuticle of the leaf.

Also a belt or sash of soft grass (?) of a brilliant yellow colour, but at the back the bright shining surface has been removed. The yellow central part is 5in. wide, with a narrow border on each side about $\frac{1}{2}$in. wide, in which the two colours are alternated, the strips being produced so as to form a fringe on each side 4in. wide. The scarf is 7ft. long, and has a very pretty appearance.

The last is a small mat made of two strips, about 11in. wide. It has a narrow border, and the strips are frayed into a fringe 1$\frac{1}{2}$in. wide. The length of the mat is about 4ft. 6in.

The whole of the articles are spotless, and in perfect preservation, and look as if they had been made but yesterday by Samoans. The finder states that they were wrapped up in some old flax mats that fell to pieces and were neglected. When he returned for these fragments the wind had blown them into an abyss, and they could not be recovered.

The whole, probably, had been procured from one of the early whaling-ships by some unfortunate Maori, who, having hidden his treasures in the cave, died without leaving instructions about his property.

Skeleton at Stewart Island.

On a recent visit to Stewart Island I found a skeleton buried in a sand cliff at the "Neck." It was in a sitting position, with the knees drawn up, and its head resting on its right hand, the other hand being on the left knee. On lifting the head I found three well-worked bone fishhook-barbs in the palm of the hand.

DESCRIPTION OF PLATES VI.–X.

PLATE VI.

Rock-pictographs at a Cave-shelter on the Maerewhenua River, Waitaki Valley.

Fig. 1. Drawn in black on the roof of the rock-shelter.
Fig. 2. On the wall, in black.
Fig. 3. Probably portion of a tattoo pattern, in black on the wall.
Fig. 4. Portion of an obliterated figure, drawn in red.
Fig. 5. Some kind of insect (walking-stick insect ?), drawn in red.
Fig. 6. Very indistinct, probably portion of a tattoo pattern, in red.
Fig. 7. A curious fish, drawn in black.
Fig. 8. Thick portion of line, drawn in red, the dotted portion in black.
Fig. 9. Outside line black, inside line red.
Fig. 10. Large fish or whale, in black.
Fig. 11. In red.
Fig. 12. A figure from the eastward end of the limestone rocks; there are remains of others at this place, but much destroyed by the weather.

PLATE VII.

Rock pictographs at the Upper Cave shelter, Maerewhenua River, and also some of the Pictographs at the Takiroa Cave.

Fig. 1. On walls at back of cave, in black. All the paintings in this cave are in black.
Fig. 2. Probably a porpoise.
Fig. 3. Porpoises: some of these are full of action. There are many examples of this form.
Fig. 4. A pattern of this kind occurs in some of the patterns for rafter-painting in the *mango-pare* series.
Fig. 5. A variation in the porpoise form.
Fig. 6. From the rock-shelter at Takiroa. This in dark-red, and is within a foot of the present surface of the floor.
Fig. 7. In dark-red.
Fig. 8. This and the last figure are given in the first volume of the "Transactions of the New Zealand Institute," pl. vii.: it is the figure in which the charge of shot is embedded; dark-red
Fig. 9. A figure in red high up to the right of fig. 11.
Fig. 10. This was regarded by Professor Von Haast as part of a moa feeding, the balance of the figure being supplied by fig. 12; in red.
Fig. 11. On the upper part of the wall of the cave.
Fig. 12. The so-called body and neck of the moa (?).
Fig. 13. A very large shark about to devour a man. There are numerous figures in the neighbourhood of this group that cannot easily be made out. They are close to the present floor. All the above figures are in red.

PLATE VIII.

Fig. 1. A very fine stone *mere* found in the Strath Taieri. It was concealed in a little cairn built up of loose slabs of schist. At the end of the handle is the appearance of a second hole having been bored, and the extreme end has broken off, either during and on account of the boring, or by accident or intent afterwards. The same process will be observed in fig. 2, where both holes are in process of formation. This seems to indicate that it was the intention of the makers to have a lunate or double-pointed ornamentation at the end. Though there are at present few examples known, I believe that such was the object. The work on No. 2 precludes the suggestion

that the perfect hole in No. 1 was bored because the other was a failure or had been accidentally broken. The length is 20in. The surface is very smooth picked work, not polished. Fig. *a* is a section across the thickest part; fig. *a''*, section through handle.

Fig. 2. A stone *mere* found in Otago, 18in. long, 3¼in. wide, 1⅛in. thick. It is of a closely-grained dark stone, very finely picked all over. No portion is in any way ground or polished. The figure is too small to show the numerous small notches along the sharp edges.

Fig. 3. A stone club of similar character, 9in. long, now in the Oamaru Athenæum Museum. It was found, I believe, in a rock-shelter near Ngapara. Fig. *b* gives a section of this and fig. 4. The hole is bored in a very curious place, and both this and fig. 4 have grooves round the end of the handle for the attachment of the usual thong.

Fig. 4 is much the same, but has a well-bored hole at the point.

Plate IX.

Photograph of the Contents of the Maori Kete *found in a Cave-shelter at Patearoa.*

Fig. 1. Small mat, just commenced (*kakahu*).

Fig. 2. Partly-prepared New Zealand flax (*whitau*).

Fig. 3. Fragment of whitebait-net (*he kaka*).

Fig. 4. Pair of doubled plaited sandals (*paraerae torua*), made from the leaves of the *ti* (*Cordyline*).

Fig. 5. Pair of plaited sandals (*paraerae takitahi*).

Fig. 6. Bag with cord attached. The bag now contains *kokowai*, but was originally intended for making the *tutu* wine, the ripe berries being placed in the bag and the juice expressed through the meshes. This kind of bag was called *pukoro*.

Fig. 7. Small twist of partly-dressed flax.

Fig. 8. Bundle of finely-prepared flax, dyed black (*whitau parapara*).

Fig. 9. Two small mats, just commenced (*kakahu*).

Fig. 10. Small bundle of leaves of *Celmisia viscosa*, probably collected for the sweet-smelling gummy matter on the leaves.

Fig. 11. Large *paua* shell, with flax handle for suspension, still containing *kokowai*, and the flax wad with which the paint was applied.

Fig. 12. Two pieces cut from the wing-bone of an albatros: one has been made into a flute, and afterwards broken; the other has not yet had the holes made in it.

Fig. 13. Two *Mytilus* shells, used for scraping the cuticle from the flax-leaf.

Fig. 14. Small flax bag or sachet of flax of curious workmanship, containing a small fragment of *mimiha*, a native pitch used as a masticatory.

Fig. 15. Small packet of scented gum.

Fig. 16. Prepared flax (*whitau*) in hanks (*whenu*).

Fig. 17. Large flax kit containing the above, and four large bundles of the tomentum from the back of the leaf of *Celmisia coriacea*.

Plate X.

Haliotis shell, with worked-flax handle for suspension, contains mixed *kokowai*, a native oxide of iron, used as a red paint for many purposes.

A well-made bag used for straining off the juice from the fruit of the tutu (*Coriaria ruscifolia*). The juice was highly esteemed as a beverage.

II.—ZOOLOGY.

Art. XIII.—*Notes on the Ornithology of New Zealand.*

By Sir Walter L. Buller, D.Sc., K.C.M.G., F.R.S.

[*Read before the Wellington Philosophical Society, 17th February, 1897.*]

Plate XI.

As this will be the last occasion on which I shall have the pleasure of addressing the Society before my departure on a lengthy visit to Europe, I desire, in the first place—before submitting my usual budget of notes—to refer to an address which I gave in June, 1894, under the title of "Illustrations of Darwinism; or the Avifauna of New Zealand considered in relation to the Fundamental Law of Descent with Modification." My object at that time was to place before the Society certain facts and inferences derived and deducible from my own observations in this country, extending over a considerable period, in support and illustration of the doctrine of the evolution of species by a process of natural selection, on Darwin's well-known principle of the "survival of the fittest." The address dealt with a debatable subject, and it will be remembered that it led to a discussion in which several members of the Society took part. In order to invite a wider criticism I had 250 extra copies separately printed, and these I distributed among scientific friends and correspondents all over the world. It was naturally very gratifying to me to receive, as I did, from many quarters appreciative and commendatory letters. It is not my purpose to refer to those letters of approval, except in this general way, as affording an indication of the common acceptance of the doctrine of evolution at the present day—as another proof, if small in its way, of the truth of Professor Newton's remark (quoted in my address) that Darwin's famous book "On the Origin of Species" had effected the greatest revolution of human thought in this or perhaps in any other century. I shall accordingly pass by these letters as a whole, and refer only to those of them which contain, in any sense whatever, adverse criticism of my treatise. My desire is to elicit the truth, whether favourable to my views or otherwise.

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In the first place, then, I will refer to a communication from Mr. Alfred Russel Wallace, the great apostle of Darwinism. It will be remembered that I ventured to differ with that eminent scientist on one or two points—chiefly as to the position assigned by him to the genus *Apteryx*. I said (p. 80*), "I cannot for a moment admit that the Kiwi is one of the lowest birds in the sense implied. It rather seems to me to be an extremely specialised form, and one to which Mr. Wallace's own felicitous remarks (at page 105†) are specially applicable: 'In species which have a wide range the struggle for existence will often cause some individuals to adopt new habits in order to seize upon vacant places in nature where the struggle is less severe. Some, living among extensive marshes, may adopt a more aquatic mode of life; others, living where forests abound, may become more arboreal. In either case, we cannot doubt that the changes of structure needed to adapt them to their new habits would soon be brought about, because we know that variations in all the external organs and all their separate parts are very abundant, and are also considerable in amount. That such divergence of character has actually occurred we have some direct evidence.'" I then proceeded to argue that the *Apteryx* was, in every way, the most specialised type of its kind—an extreme form of degeneracy, using that term in its Darwinian sense.

Mr. Wallace, in acknowledging receipt of my pamphlet, writes in appreciative terms of the paper as a whole, and stating that on the only points on which he disagreed with me he had communicated an article to *Nature*. On turning this up (vol. lii., p. 60) I find the following criticism: "Its main subject-matter is a discussion of the various ways in which the peculiarities of structure, colour, distribution, and habits of New Zealand birds serve to illustrate the theory of natural selection, and often to afford very strong arguments in its favour. The address is very clear and forcible, full of interesting facts and suggestive observations, and will be read with interest by all naturalists. One or two points only call for any critical observation. Sir Walter Buller objects to the *Apteryx* being classed by Mr. Wallace as among 'the lowest birds,' because he says it is really 'an extremely specialised form.' But surely the Ratitæ are lower than the Carinatæ, and the *Apteryx* is so specialised as to be almost the least bird-like of the Ratitæ. If it is not to be classed among the lowest existing birds, where are they to be found?"

It will be seen, on referring to what I said, that what I objected to was the placing of the Kiwi among the lowest

* Trans. N.Z. Inst., vol. xxvii.
† "Darwinism."

forms of bird-life "in the sense implied." In the sense now used by Mr. Wallace, I admit, of course, that the Kiwi as a Ratite form comes at the end of the chain in our modern system of classification; but, as I understand it, that is a very different point to the one I was discussing. In accordance with that system, and having regard to their natural affinities, I have placed the group of Kiwis at the very end of my "Birds of New Zealand," but that is in no way inconsistent with my argument as to *Apteryx* being a highly specialised form. Writing of this bird, the late Professor Owen said: "Here we have a true bird, exhibiting a remarkable modification of the whole ornithic structure, in reference to exclusively terrestrial life and nocturnal habits; and we learn, from this adherence to a typical organization, in a very rare exception, that the teleological conclusions respecting the typical construction, as it is manifested in the general rule, are in no way affected by such an exception, because the modification of one part necessarily affects that of many others, perhaps of the whole body. If, for example, the fixation and structure of the lungs require a broad sternum and concomitant modifications of the coracoid and scapula for the mechanical part of the respiratory process, then it may be more convenient for the levator of the humerus to rise below that bone from the sternum, and act in the due direction by a modification of its course, although the locomotion of the bird may in no way be facilitated by the aggregation of muscular substance beneath the centre of gravity, nor the size of the levator be such as to render its particular position a matter of any consequence in regard to that centre."

Professor Newton, in his admirable article on "Birds" in the "Encyclopædia Britannica," referring to the extraordinary development of our Ratitæ, says: "If we take the birds alone, and compare the two subclasses into which the existing or recent members of the class are divided, we find the Australian region remarkable for its ornithic singularity. The smaller of these two subclasses, the Ratitæ, contains six very natural groups—which might well be called orders—including, according to the most exaggerated computation of their number, less than forty species, while the large subclass, the Carinatæ, comprehends some ten thousand species." In a footnote he adds: "If it be true, as seems to be most likely the case, that *Dinornis* and its allies were absolutely devoid of wings, we should in them have a divergence from the normal ornithic type which is altogether unique in the whole class, and for its singularity might well be set off against the multifariousness exhibited by the Didelphia"—one of the subclasses of mammals characteristic of the Australian region.

Mr. Wallace's criticism proceeds: "Again, the statement

that the larger forms of animals have universally preceded the smaller in geological time (p. 101) is only a half-truth, if so much, since all these large forms have been developed from smaller ones, as shown in the case of the horse, as well as that of the early marsupials of the Mesozoic period. Even more open to objection is the statement (p. 102) that the Siberian mammoth 'would clearly have required a growth of tropical luxuriance to satisfy the wants of its capacious stomach'; and that its being found by thousands imbedded in ice or frozen soil implies 'a revolutionary change of climate.' A sufficient answer to this theory is the fact that leaves and cones of firs have been found in the stomach, showing that it fed only a few degrees south of the places where it is now imbedded."

Another very distinguished scientist, however (Sir Joseph Hooker), takes a somewhat different view. He writes: "Yesterday I received yours of 10th May, and this morning your 'Illustrations of Darwinism.' Such is my avidity for anything relating to the natural history of New Zealand that I read your papers through at once and with very great pleasure. They reminded one of 'White's Selborne,'* and interested me exceedingly. I go along with you throughout the Darwinism discussion, especially with regard to so-called degraded types being in reality advanced ones. The only criticism which I would offer is that (p. 102) too much stress must not be put on the correlation of gigantic animals with a luxuriant and, especially, a tropical vegetation. I think that the contents of the stomachs, or an examination of the teeth, at any rate, of Siberian mammoths prove them to have fed on birch, willow, and other shrubs like the existing dwarf plants of the tundras; and elephants swarmed at the Cape of Good Hope itself when discovered, and for years afterwards. The Greenland whale feeding on minute mollusca is an analogous case, and there are a multitude of others. There is no reason to

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* To my mind Sir Joseph Hooker could not have paid a higher compliment to the literary quality of these papers. From boyhood "White's Natural History of Selborne" has been one of my favourite books, as I suppose it has been with every student of ornithology. It is thus referred to by the learned author of the article on Ornithology in the "Encyclopædia Britannica": "It has passed through a far greater number of editions than any other work on natural history in the whole world, and has become emphatically an English classic, the graceful simplicity of its style, the elevating tone of its spirit, and the sympathetic chords it strikes recommending it to every lover of Nature, while the strictly scientific reader can scarcely find an error in any statement it contains, whether of matter of fact or opinion. It is almost certain that more than half the zoologists of the British Islands for the past seventy years or more have been infected with their love of the study by Gilbert White, and it can hardly be supposed that his influence will cease."

suppose that the bogs over which the Irish elk roamed and fed supported a more luxuriant vegetation than they now do."

"How profoundly interesting is the islet fauna of New Zealand! Much of this is new to me. I wonder when their plants will receive the same treatment as you give to their birds, &c. I hope that you will gather your facts into a general work on the natural history of New Zealand. Your difficulty will then be to keep it down to a moderate size, especially as I hope you will illustrate plentifully. A good map will be necessary, as it is impossible to find in the ordinary ones many of the places you mention. I am always glad to see Colenso's name brought forward. I wish he could have been persuaded to treat of plants as you have of animals. As it is, I can only marvel at the results of his eye-work as a collector and his indefatigable industry, zeal, and self-denial; and I look back on my weeks of personal intercourse and years of active correspondence with him as a long episode of New Zealand in my life."

As anything written by Sir Joseph Hooker is of special interest to New Zealand readers, I will give just one more extract from his letter: "You may be interested to know that I am printing Banks's 'Narrative of Cook's First Voyage,' which is full of matter not contained in 'Hawksworth,' and will, I hope, give an unexpected view of Banks's marvellous industry and powers of observation as a naturalist and ethnologist. The journal is of portentous length, and to bring the best parts into a volume of four hundred pages I shall have to omit a multitude of details of daily life at sea—of no interest—and much of the nautical details already published by Hawksworth; also many long passages relating to the customs of the natives that will not bear reproduction—most of which are, indeed, in 'Hawksworth' already. Though I, through my father, who was intimate with him, have, I suppose, heard more of Banks than any other living man, I never before realised, what my father used to affirm, his great knowledge as a naturalist, and his powers."

From Mr. Roland Trimen, F.R.S., the Director of the Cape Museum, I have a very similar criticism: "In your very interesting 'Illustrations of Darwinism,' &c. (p. 102), I notice that you refer to the case of frozen mammoths in Siberia as indicating a *very sudden* change from tropical to arctic conditions there; but it has always seemed to me that the change must have been very gradual indeed until the final unexplained catastrophe, because not only were the mammoths clothed with shaggy hair, but the last food they took (as shown by the undigested and actually unaltered quantity in their stomachs) consisted of shoots of the very same species of *Pinus*, &c., which now flourish on the tundra wastes."

Lord Kelvin, the late President of the Royal Society, after thanking me for the address, says: "You and the geologists must, however, be satisfied with twenty million years for the earth's age. The 306 million years for the denudation of the Weald in Kent, given as part of his foundation in the first edition of 'The Origin of Species,' was dropped by Darwin himself after I showed it to be inconsistent with dynamics, and I think you will not find it in the third or later editions. The 270 million years 'since the Cambrian period,' which you quote from Lyell, is utterly untenable. He supported his assumption of infinite past time for geology by a thermo-electric invention of a perpetual motion as good as many of the million 'perpetual motions' that have been invented by ingenious persons who have not learned dynamics or physics."

A *sufficient* length of time was my postulate; and twenty million years suits my argument quite as well as the more-extended period.

Sir John Lubbock, F.R.S., whom I gently twitted with inaccuracies, whilst I admitted to the fullest extent the charm of his writings, writes to me: "Many thanks for the 'Illustrations,' which I have read with much interest. Huia is, of course, allied to the Crow, and I said Crow rather than Starling as giving a better idea of the size and colour. I observe you say that the female 'comes to the aid' of the cock, so that my account does not differ so very much from what you say. Probably if the cock has not had enough he would take some."

Professor Parker, F.R.S., writes: "I have read your article, 'Illustrations of Darwinism,' with some care, and approve highly of most of it. There are a few criticisms I should like to make.

"P. 79. The upper mandible (of *Apteryx*) is a prolongation of precisely the same bone as in other birds—premaxillæ, nasals, &c. The 'cranial pan' is rather exceptionally large in *Apteryx*. I have often wondered what it wants with such a big brain.

"P. 80. You are quite right about the extreme specialisation of *Apteryx*. See my paper on its development: 'Philosophical Transactions, 1891,' summary, p. 116. See also the brief account of the matter in the 'New Zealand Journal of Science' (sent herewith).

"P. 85. *Megalapteryx* is not a 'Giant Kiwi,' but a Moa, as Lydekker first showed.

"P. 87. My observations on the skull of the Dinornithidæ (see Proc. Zool. Soc., 14th Feb., 1893) distinctly contradict your view that the larger forms of Moa are the most ancient. The oldest (least specialised, &c.) type of skull is *Mesopteryx* (including *Casuarinus*, *Didinus*, &c.), while the very tall forms

(*robustus*, *giganteus*, &c.) and the thick-legged forms (*elephantopus* and *crassus*) are highly specialised in different directions.

"Your observations on the numerous species of *Apteryx* and their distribution are very interesting. What strikes me at once is, what a pity that the skeletons are not properly described. If you ever have the chance of getting any, I wish you would lend them to me for that purpose. I think I may say without undue vanity that I could monograph the skeleton of *Apteryges* as well as most men. Unfortunately, it is of little use to begin until one has a good series of well-authenticated specimens of all the species, and I am sorry to say I cannot give the collectors *carte blanche*."

I am glad to add that I have since been able to procure for Professor Parker a specimen in the flesh and two rough skeletons of the Giant Kiwi (*Apteryx lawryi*) from Stewart Island. He has devoted special attention to the anatomy of *Apteryx*, and his remarks quoted above are therefore valuable.

In my address (at p. 87) I gave reasons for my conclusion that the larger forms are the more ancient, being those that roamed originally over the afterwards submerged continent, and that the smaller-sized Moas, of different genera and species, are the descendants of those which had been specialised in the various islands during the long epoch following the continental submergence. As will be seen, Professor Parker differs with me on this point. I mentioned, on the page already cited, Captain Hutton's published view that the smaller forms of Ratitæ in New Zealand must have preceded the larger, but I also quoted from his paper "On the Moas of New Zealand" (Trans. N.Z. Inst., vol. xxiv., p. 149) a passage which seemed to show that a difficulty about this existed in his own mind. It was this: "Evidently *Anomalopteryx* and *Palapteryx* are the oldest forms; but if *Palapteryx* had wings it could not have been derived from the wingless *Anomalopteryx*, and, if the birds were increasing in size, *Anomalopteryx* could not have been derived from *Palapteryx*." I added, by way of commentary, "Exactly so; but on my hypothesis these difficulties disappear, and the supposed conditions are in harmony with it." It would seem that Captain Hutton—who has studied the subject very closely, and whose opinion is entitled to great respect—has arrived at the same conclusion as myself, for in a very interesting article lately communicated by him to the Canterbury *Press** he says: "The commoner kinds of Moas were comparatively small birds, from 3ft. to 5ft. high, and it seems probable that the giants of the race, which attained a height of about 12ft., had all died out before the

* "The Rise and Fall of the Moa," by Captain Hutton, F.R.S.—The *Press*, 2nd November, 1896.

advent of man. At any rate, there is no record of any bones of *Dinornis maximus* or of *Dinornis giganteus* having been found among the remains of Maori feasts."

Before passing on, I may say that it was a matter of regret to me that my address had caused pain or annoyance to a member of our Society, who wrote to me saying that my strictures on his paper had been far too severe. I can only answer him in his own words, "*Magna est veritas, et prævalebit.*" Whilst vindicating the truth from my point of view, there was no desire on my part to wound; and that I kept within reasonable limits is, I think, sufficiently attested in the following letter from Dr. Morris, C.M.G., the assistant director at Kew: "You evidently have to hold the torch of science with no uncertain light in the antipodean community to keep out error and conclusions opposed to truth. I admire your frank, outspoken words, for, while they undoubtedly will reach conviction, they will not cause ill-feeling nor sympathy for the vanquished, as is too often the case in the conflict between the trained and untrained in scientific discussions." This being the view of a competent judge, looking on from outside, I cannot believe that I have abused my undoubted right of criticism, or made myself too personal.

I now invite the attention of the Society to some brief notes on various species of native birds, in continuation of similar contributions on former occasions.

Miro albifrons, Gmelin. (South Island Robin.)

A partial albino received from Canterbury has the back and under-parts entirely white; the rest of the body-plumage slaty-black and white intermixed irregularly; quills and tail-feathers normal. Bill bright-yellow; legs darker yellow.

Sphenœacus punctatus, Quoy and Gaim. (Fern-bird.)

I have received a pair of Fern-birds from Stewart Island, which seem to represent a larger race than the one inhabiting the North and South Islands. In plumage it is precisely similar, except that the black spots on the breast appear to be more pronounced. The male gives the following measurements: Total length, 7·5in.; wing from flexure, 2·75in.; tail, 3·75in.; bill, along the ridge, 0·5in.; along the edge of lower mandible, 0·7in.; tarsus, 0·9in.; middle-toe and claw, 0·85in.

Sphenœacus rufescens, Buller. (Chatham Island Fern-bird.)

A collector living on Pitt Island states that, partly through the firing of the low vegetation and partly through the introduction of cats which have run wild, this interesting species has become quite extinct.

Anthus novæ-zealandiæ, Gmelin. (New Zealand Pipit.)

A partial albino from Canterbury has the upper surface of wings, sides of body and abdomen, scapulars and tail-feathers greyish-white; the rest of the plumage normal. A specimen which I saw in Dunedin in January last had the entire plumage of the body pure white, the head only betraying the natural colours.

Rhipidura fuliginosa, Sparrm. (Black Fantail.)

One of these birds in perfect plumage was recently seen in the bush reserve at Papaitonga, where it was associating with the ordinary Fantail. As the occurrence of these stragglers from the South Island has become more numerous of late years than formerly, there is some chance of the species establishing itself in the North Island.

Anthornis melanura, Sparrm. (Bell-bird.)

To the accidental varieties which I have previously recorded I have now to add an albino from Akaroa, the whole of the plumage being white, slightly tinged with golden-yellow.

Specimens of this bird from the Auckland Islands appear to be, as a rule, a trifle larger than New Zealand examples.

Prosthemadera novæ-zealandiæ, Gmelin. (Tui.)

From Stewart Island I have received a beautiful albino of this species. The whole of the plumage is of the purest white; the bill and the feet are also white.

Xenicus longipes, Gmelin. (Bush Wren.)

At Milford Sound in February last I saw a single example of this very rare species, and managed to procure it undamaged with a small charge of dust-shot. I saw another a few weeks later on Stewart Island. It was in a low shrub by the roadside, and on my approach descended quickly to the ground, but it was so nimble in its movements that I was unable to get a shot at it. The specimens sent to me by Mr. Brough were captured by him by means of a hand-net, and, as specimens, were entirely uninjured. Writing to me of this species, he says: "On my last visit to the mountains I found four very neatly made nests of the Bush Wren. They were placed under an overhanging clay bank, but there were no eggs in any of them. I found out when I was living for months in this solitude among the Wrens that if by chance you wound or hurt one it is sure to fly away to its nest. I observed, too, that in wet or stormy weather they rest in their old abandoned

Xenicus insularis, Buller. (Island Wren.)

Very diligent search has been made on Stephen Island for further specimens of the Island Wren, but without success, and there is too much reason to fear that this species has, almost immediately after its discovery, become extinct. It is much to be regretted that there is not a specimen in any one of our local museums.

I am informed by Mr. Henry Travers that he sent seven examples (including two in spirits) to the Hon. Walter Rothschild. It is a comfort, therefore, to know that this vanished species will, at any rate, be well represented in the magnificent New Zealand collection now existing in the Tring Museum. Of its habits, unfortunately, we know nothing. Mr. Lyall, the lighthouse-keeper, through whom, I believe, all the specimens were procured, reports that, so far as he could judge, it was crepuscular in its habits. If that be so, it is certainly a very interesting fact in the natural history of such a bird.

Halcyon vagans, Lesson. (New Zealand Kingfisher.)

I have already placed on record many observations showing the predatory character of our Kingfisher. The following note received from Captain H. F. Way is only another count in the indictment: "Whangamata, 22nd November.—The other day, while I was waiting at the entrance of a drive for my mate to turn up (7 a.m.), I noticed a lot of Blight-birds (*Zosterops*) flying about a tree; then I heard a strange noise—whack-whack-whack. At first I could not make out where the noise came from—another whack. Presently I saw a Kingfisher sitting on the branch of a tree with something in his beak. Then came a rapid succession of whacks—first to the right, then to the left—and I noticed something flying about in the air. Then I made out that he had a Blight-bird in his beak, and was a-whacking the poor little beggar on the branch to get rid of the feathers. As fast as he got rid of the feathers so he kept on swallowing the bird, and the last thing I saw of the latter was his legs protruding from the Kingfisher's beak. The most singular thing was the vigour with which the Kingfisher struck his victim against the branch—generally three whacks on each side and then a rest, and so on to the end."

Platycercus novæ-zealandiæ, Sparrm. (Red-topped Parrakeet.)

There is a remarkable example of this widely-spread species in the Southland Museum. The curator (Mr. Fraser) very courteously unscrewed the face of the glass case containing it, to enable me to make a closer inspection: Forehead and front part of vertex, as well as the ear-coverts, dark-crimson; the whole of the body-plumage bright-yellow, varied more or less on the upper surface, and washed on the neck with green;

bastard quills and outer webs of first four primaries, in their basal portion, blue; the rest of the primaries brownish-grey, clouded with darker grey on their inner webs; the fifth primary in each wing yellowish-white, the outer vane changing to yellowish green towards the base; the two middle tail-feathers dark-green, edged and tipped with yellow, and the lateral ones varied and clouded with green; the under tail-coverts washed with green. Bill normal; feet pale-brown. This specimen is marked "Female," and there is a note attached stating that it was obtained in December, 1876.

Platycercus auriceps, Kuhl. (Yellow-topped Parrakeet.)

I have described elsewhere the beautiful yellow Parrakeet in the Colonial Museum. There is an equally lovely object in the Southland Museum: On the forehead there is the usual mark of arterial red, and with this exception the whole of the plumage is of a vivid canary yellow; primaries and their coverts white. Bill and feet white.

Platycercus cooki, Gray. (Norfolk Island Parrakeet.)

The confusion about this species appears to have been cleared up at last. The *Ibis* of last year (p. 156) contains the following: "Mr. North, having procured two authentic specimens of the Parrakeet of Norfolk Island, admits that Count Salvadori was correct in stating (*Ibis*, 1893, p. 466) that the species is quite distinct from *Cyanoramphus novæ-zealandiæ*, and that *C. rayneri* is identical with *C. cooki* — the proper name for the Norfolk Island bird. It would seem that the species of this genus which formerly inhabited Lord Howe's Island has become extinct." So, I may add, has that which, a few years ago, inhabited Macquarie Island.

Nestor meridionalis, Gmelin. (The Kaka.)

I have received a beautiful specimen of *Nestor meridionalis* from Stewart Island—another form to be added to the remarkable series of well-marked varieties enumerated in my "Birds of New Zealand." The general plumage is of a delicate fawn-colour, flushed more or less with orange, particularly on the upper wing-coverts, the feathers of the back having darker margins; ear-coverts orpiment-orange; the overlapping feathers on the cheeks dark wine-red; nuchal collar conspicuous, and of red and orange intermixed; croup and upper tail-coverts, lining of wings, abdomen, and under tail-coverts arterial red; feathers on the breast and those along inner margin of wings with yellow and red crescents and dark margins; tail-feathers strongly flushed with reddish-orange. Bill and feet whitish-horn colour.

Nestor meridionalis, var. *esslingii*, Gould.

I have had an opportunity of examining another of these birds from Collingwood. It is a very handsome bird. The bill is finer or more produced than in ordinary specimens of *Nestor*, and the shafts of the tail-feathers project half ani nch beyond the webs. The colours are very brilliant; the overlapping cheek-feathers are vivid wine-red, and the ear-coverts are bright orpiment-orange. The nuchal collar of red is continued all round the lower neck, the upper breast-feathers having arterial red and orange borders; on the feathers immediately below, the red disappears and the orange is more spread; the transverse belly-band, which is of a brilliant canary-yellow, is 2·5in. wide; the lower abdominal feathers, with the flanks and under tail-coverts, are, like the croup and upper tail-coverts, banded with bright arterial-red. On the crown and hind-head the grey is shaded with dusky, and the feathers have a greenish tinge; many of the small wing-coverts have brilliant tips of arterial-red and yellow; the toothed markings on the under-surface of the quills are very conspicuous and of a pale-red colour; the tail-feathers are flushed underneath with red for two-thirds of their length, then they are dark-brown, with a terminal band of obscure-red, beyond which the black shafts are produced in extremely fine points. The plumage of the upper-surface is greyish-brown, tinged with green, and with broad black margins to the feathers. The colours are distinct and pronounced, and, this being the fourth example since Gould's *Nestor esslingii* was described, one is tempted to recognise a distinct species, the yellow sides on the lower mandible showing an approach to *Nestor notabilis*. But I feel constrained to regard it still as a variety of the highly variable *Nestor meridionalis*, because I think I can detect undoubted signs of albinism. In the right foot the terminal scale on each toe is white, while in the left foot nearly the whole of one fore-toe and one hind-toe are white, even to the claw of the latter, besides two scutella on each of the other toes. It gave the following measurements: Extreme length, 21in.; wing from flexure, 12in.; tail (to end of produced shafts), 8in.; bill, along the ridge, 2·25in.; along the edge of lower mandible, 1·50in.; tarsus, 1·25in.; longer fore-toe and claw, 2·75in.; longer hind-toe and claw, 2·25in.

Nestor meridionalis, var. *superbus*, Buller.

I have received a very beautiful example, of which the following is a description: General plumage canary-yellow, with brighter washes of yellow on the breast, shoulders, and upper-surface of wings; ear-coverts orpiment-orange; feathers overlapping under mandible wine-red; broad nuchal collar orpiment-orange and red intermixed; lower part of back,

croup, and upper tail-coverts bright-scarlet; under-surface of wings, sides of the body, abdomen, flanks, and under tail-coverts scarlet, mixed more or less with orpiment-orange; quills and tail-feathers greyish-white, the former toothed on their inner webs with yellow and crimson, the latter with red.

Carpophaga novæ-zealandiæ, Gmelin. (New Zealand Pigeon.)

A partial albino from Martin's Bay has the breast metallic-blue and green intermixed; upper part of breast and small upper wing-coverts rich vinous-brown; back pale bluish-green and grey; scapulars largely marked with white; upper-surface of wings pale bluish-green and brown intermixed; quills margined and tipped with pale-brown; tail-feathers brown, tipped with brownish-white; under tail-coverts dark-cream colour.

In the Hawke's Bay Museum there is an almost perfect albino, the whole of the plumage being white, with the exception of a sprinkling of coppery-brown feathers on the head and upper-surface of wings. In the Wanganui Museum there is a peculiar example of partial albinism, already described by Mr. Drew. This bird looks just as if it had been sitting out in a fall of snow, the head, shoulders, and more-exposed portions of the back being perfectly white, and presenting a striking appearance.

At Otaki I recently saw a perfectly tame one in the possession of the Maoris. It would perch on the shoulder, take food from the hand, and show in an unmistakable manner that it was quite at home in the hut of which it was allowed the freedom.

Charadrius obscurus, Gmelin. (New Zealand Dottrel.)

Mr. Marklund has sent me two skins of this well-known species, in summer plumage, which he obtained on Table Hill, on Stewart Island, at an elevation of 2,100ft. above the sea-level, and at a distance of fully eight miles from the coast, with heavy intervening bush-country. They were breeding there, for he saw the unfledged young ones.

Thinornis novæ-zealandiæ, Gmelin. (New Zealand Shore-plover.)

In a case of stuffed birds, at Invercargill, on the occasion of a recent visit, I observed the young of the above rare species, the specimen, as I was informed by the taxidermist, having been obtained at the mouth of the Cargill River.

Hæmatopus longirostris, Vieill. (Pied Oyster-catcher.)

Young of the First Year.—Differs from the adult in having the white of the under-parts intermixed with the black in

about equal proportions, there being no pectoral line of demarcation. The lining of the wings is varied with white, in an irregular way, down the line of the humerus, the quills are greyish-white towards the base on their under-surface, and the under tail-feathers are tipped with white. The secondary coverts are white in their outer portion, but on one web only, the alar-bar being somewhat broken along the edges; and the under tail-coverts are narrowly margined with white. The specimen from which these notes are taken was captured at the Pelorus Sound in the month of January.

Tringa canutus, Linn. (Knot.)

Referring to Mr. Cheeseman's specimens, shot by his brother in Hobson's Bay, I said, in my "Birds of New Zealand" (vol. ii., p. 36): "This is the first authentic record of this species in the North Island; but Captain Mair has described to me a bird found associating in considerable numbers with the Godwit on the East Coast, which I have no doubt is the same."

I have received some fine specimens, in both summer and winter plumage, from Cape Farewell. A male bird gave the following measurements: Length, 10·5in.; extent of wings, 19·5in.; wing from flexure, 6·5in.; tail, 2·75in.; bill, along the ridge, 1·25in.; along the edge of lower mandible, 1·12in.; tarsus, 1·12in.; middle toe and claw, 1·1in.

The female is slightly smaller in all its proportions.

Porphyrio melanonotus, Temm. (Swamp-hen.)

A partial albino obtained at Lake Ellesmere has the entire body varied with pale-brown and white feathers intermixed with the ordinary plumage, the feathers composing the mantle being almost entirely pale-brown and brownish-white; wings and tail normal, except that the primaries are whitish on the outer vane towards the base; under tail-coverts pure white. Another specimen from the same district has a few white feathers scattered over the breast and among the wing-coverts, whilst all the quills and tail-feathers are pure white, with terminal bands of brownish-black.

Ocydromus greyi, Buller. (North Island Woodhen.)

This once very common species—whose cry, by the way, exactly resembles that of the European Curlew—is fast disappearing. In districts where only a few years ago it was extremely plentiful its shrill cry is now seldom or never heard.

On a recent visit to Hawke's Bay I saw a lovely albino of *Ocydromus greyi*, obtained in the Mohaka district. The whole of the plumage is snow-white, with the exception of a small patch between the shoulders, the croup, and the upper

tail-coverts, which are of the normal colour; bill and feet pale reddish-brown.

Mr. Morgan Carkeek, who has recently returned from a two months' surveying expedition through the mountainous country in the interior of the Marlborough District, found, to his astonishment, that the South Island Woodhen had vanished altogether, for he had met with only a single example during the whole of that time. He attributes this result entirely to the ravages of the imported stoats and weasels, which have become fairly established in that country.

A specimen of *Ocydromus greyi* which I received from the Hutt Valley had the quills of the wings entirely black, without any barred markings. On some of the secondaries there were obsolete bars, but very obscure and broken. A specimen of *Ocydromus earli* from the West Coast (Martin's Bay), on the other hand, had the quills entirely chestnut-brown, owing to a complete fusion of what, in ordinary birds, are barred markings of that colour.

Ocydromus australis, Sparrm. (South Island Woodhen.)

I have received two albino specimens of this species from the South Island. One is a male bird from Otago, in which the whole of the plumage is pure white, with the exception of a slight creamy tinge on the shoulders and upper-surface of wings; bill and feet whitish-horn colour. The other is a female bird from Canterbury. This, too, is all white, except that vestiges of the normal plumage appear on the wings and flanks, and an irregular sprinkling of brown on other parts of the body; there is also a shade of ash-grey on the abdomen.

Ocydromus earli, Gray. (Brown Woodhen.)

I have received from Westport two partial albinoes of this species marked almost exactly alike. They are both males, and, having been captured at the same time, they presumably belonged to the same clutch. The finer one of the two has the forehead, sides of the head, throat, fore-neck, breast (with the exception of a central patch of brown), and the whole of the abdomen, sides of the body, and flanks pure white; the rest of the plumage normal. The other bird is almost exactly similar in plumage, but has a little more brown on the sides of the head, a larger patch of brown on the breast, and an admixture of brown with the white of the abdomen and thighs.

I obtained one example of the Brown Woodhen on Stewart Island, and I am assured that the Black Woodhen is found there also.

We had landed our party at Price's Cove, in Paterson's Inlet, a charming spot near a sandy beach, enclosed by a thick belt of vegetation, among which the beautiful *Senecio*

rotundifolia was conspicuous. Kindling a fire in front of a huge block of granite, we put on our "billy" of tea, and prepared for an *al fresco* lunch. Whilst this was proceeding a Woodhen came out of the bush, and, with characteristic curiosity, peered round in its usual stealthy manner to see what we were about, coming right out on to the beach and approaching to within a few feet of our party. I drove him off to a convenient distance, and then brought him down with a very small charge of shot. He proved to be a male of the above species, and was in very fat condition. I found his crop gorged with the berries of the tataramoa bramble (*Rubus australis*), with which the ground, as I had noticed, was plentifully strewed in the vicinity of our camp.

Ocydromus brachypterus, Lafr. (Black Woodhen.)

Of this species I obtained a fine specimen in Dusky Sound in January last. It was very abundant in this locality during Sir James Hector's exploration in 1865, but it is now scarce, and this was the only one I even heard of during our visit. I have since received one from Stewart Island, also a chick, of which I took the following note: Apparently about a month old (end of November); covered with thick and long blackish-brown down, which has evidently taken the place of an earlier growth—short, woolly, and of a greyish-black colour—vestiges of which are still to be seen on the back of the neck and above the shoulders; feathers of a blackish-brown colour are beginning to appear on the shoulders and on the sides of the neck and body, the latter barred with paler brown.

Cabalus modestus, Hutton. (Hutton's Flightless Rail.)

There seems little doubt that this remarkable form has, like its larger congener of the Chatham Islands, *Cabalus dieffenbachii*, become extinct. The small island of Mangare, on which it was originally discovered, and whence fortunately a good many specimens have been obtained for the various museums, is now overrun with cats, besides which the native vegetation has been burnt off for the purpose of sowing grass-seed, even this bleak spot having been annexed by the enterprising sheep-farmer.

The occurrence of these flightless forms of bird-life in detached insular areas is a most interesting and suggestive fact in the zoology of this sub-region, as I have more than once pointed out, and it is of the utmost scientific importance that we should obtain full information as to the structure and anatomy of these peculiar endemic species before they pass away for ever.

The flightless Waterhen of Tristan d'Acunha (*Gallinula*

nesiotis) was discovered by Sir George Grey in a very peculiar way, already recorded by me.* In forwarding a living example of it to the Zoological Gardens, Sir George reported that "it can flutter a little, but obviously uses its wings and not its legs as a means of escape." On examining this form, Dr. Sclater, who named and described the species, found that the wings, sternum, and coracoids are all reduced in length, and the crest of the sternum in depth, in comparison with the same bones in the European Waterhen (*G. chloropus*), whilst, on the other hand, the thigh-bones and pelvis are increased in length, the former by four lines, relatively to the same bones in the common Waterhen. "Hence," as Mr. Darwin remarks, "in the skeleton of the natural species nearly the same changes have occurred, only carried a little further, as with our domestic ducks, and in the latter case I presume no one will dispute that they have resulted from the lessened use of the wings and the increased use of the legs."†

Phalacrocorax punctatus, Sparrm. (Spotted Shag.)

An albino of this species from Canterbury has the whole of the under-parts pure white; entire upper-surface very pale brown, the centre of each feather dark; varied on the hind-neck and on the right shoulder with grey, the feathers on the latter having darker margins; back, rump, and thighs, also wings and tail, very pale-brown, varied more or less with darker brown; on the left side the white on the neck and breast has an ashy shade, the broad white stripe from the back of the eye down the side of the neck being very conspicuous.

Phalacrocorax varius, Gmelin. (Pied Shag.)

It is a very curious fact in local distribution that this species of Shag is commonly found only at the far north and in the far south. On a visit to Stewart Island in February last I met with several shaggeries of this species in Paterson's Inlet. The birds were rather shy, but I was able to get some by rowing in a boat straight up to the overhanging trees, and, having brought them out of the shaggery, shooting them as they circled overhead. I obtained two pairs, and as they were in good plumage I converted them all into specimens. In both sexes the high colouring on the soft parts of the face is very conspicuous. In front of the eye there is a broad pear-shaped bare patch of vivid orange, and the rest of the naked membrane enclosing and surrounding the eye is of a bright mazarine-blue, changing to turquoise-green on the eye-

* "Birds of New Zealand," vol. ii., p. 104.
† "Animals and Plants under Domestication."

lids. The irides are clear sea-green. I measured the larger male, with the following result: Extreme length, 33in.; extent of wings, 50in.; wing from flexure, 12·5in.; tail, 6·75in.; bill, along the ridge, 3in.; along the edge of lower mandible, 4in.; tarsus, 2·25in.; longest toe and claw, 4in. The female is similar to the male, but somewhat smaller in all its proportions.

The nest of this Shag is comparatively small for the size of the bird, and is composed of dry twigs laced together, and becoming so compact under the pressure of the sitting bird that it is a difficult thing to dislodge them from the tree. The cavity is rather deep, and carefully rounded off on the inside. I could only examine one of them, which the boy, who had partially climbed the tree, succeeded in dislodging with the boat-oar.

I obtained only two eggs, and these were too much incubated to be blown. They are ovoido-elliptical in shape, but with a distinctly smaller end, measuring 2·37in. by 1·37in. The shell is of a pale-green colour, but this is much obscured by a rough, chalky matter which is pretty evenly distributed over the entire surface. Both of the eggs were much soiled through contact with the birds' feet, and they contained embryos apparently just ready for extrusion. This was at the end of February.

Phalacrocorax novæ-hollandiæ, Stephens. (Great Sea-shag.)

I had recently an instance of the marvellous vitality of this bird. I was standing, gun in hand, on the western point of the island in Papaitonga Lake when I observed one of these Shags at a high elevation coming in from the sea. Taking a very long shot, I gave him the choke-barrel, and saw at once that my bird was hard hit, for he immediately doubled back and made for the sea. After a flight of nearly half a mile, at full speed, he came down into the lake with a splash, and on being picked up shortly afterwards was found to be shot in the head.

I have received from Stewart Island a female of this species in full plumage with a well-defined "mane," or nuchal crest, from which it is clear that both sexes possess this adornment at that season.

Phalacrocorax stictocephalus, Bonap. (Black Shag.)

I have much pleasure in adding this species to our list of indigenous New Zealand birds, on the authority of a skin recently received by me from Mr. A. T. Pycroft, of Opua, Bay of Islands. It is the same bird as that inhabiting Australia, and named *Phalacrocorax sulcirostris* in Gould's folio edition, although, subsequently, in his "Handbook of

the Birds of Australia," he adopted Bonaparte's name as above. The species was, if I remember aright, included in Mr. G. R. Gray's "List of New Zealand Birds," of 1862, on the authority of specimens said to have come from New Zealand, but, not having been met with again, it has dropped out of our list as of doubtful origin, the last reference to it being in Captain Hutton's Manual of 1872, with this note: "I have seen no specimens." It is satisfactory, therefore, to be able to reinstate it on indubitable evidence. Accompanying the specimen, I had a letter from Mr. A. T. Pycroft, from which I extract the following:—

"I am sending you by parcels post a skin of a small Black Shag which was shot at the mouth of the Waitangi River in July last. I have sent the Auckland Museum two skins similar to the one which I am sending to you. Mr. Cheeseman favours the idea that this bird is a distinct species from the White-throated Shag (*Phalacrocorax brevirostris*). From the information which I have collected myself I should think it was a distinct bird; but I should feel satisfied if you would kindly take the trouble to examine the skin and tell me if it is so or not. I cannot, unfortunately, tell you if it was a male or female. Seven of these birds were shot at one shot at Waitangi, and there were fully one hundred of them in a flock. They were all black, and I can give you indisputable evidence to that effect. Some would remain on the surface while the remainder were fishing. It is a shy bird, and I have always had trouble to get within range. However, that time we surprised them, and were within about thirty yards of them. During the same day, at the Haumai Creek, I shot a White-throated Shag. This bird, compared with the other varieties here, is rare. The small Black Shag appears in numbers in the winter, but I have not seen it later than September. I know nothing about their breeding-places or habits. It seems strange to me that, if it is a variety of *P. brevirostris*, I have never seen any of them with any sign of white. I should think that if it was a variety I should have seen White-throated Shags amongst them."

Mr. Gould writes that this Shag "is found in most of the southern parts of the Australian Continent, and appears to affect the rivers and lagoons of the interior rather than the sea-coast; at least, such was the result of my observations. I found it nowhere more abundant than on the Rivers Mokai, Peel, and Namoi. Its habits did not appear to differ from those of the other members of the family; it was usually seen perched on the branches of the eucalypti overhanging the water, and on the spars and snags of the fallen trees which protruded above its surrface, in small companies of from

five to twenty in number. Its food consists of fish, frogs, newts, &c."

Dysporus serrator, Gray. (Gannet.)

Through the kind attention of Mr. Hill, the Inspector of Schools at Napier, I had recently an opportunity of visiting a famous breeding-ground of the Gannet at Cape Kidnappers. The following short account of my visit may be interesting to members of the Society.

In the afternoon of the 30th December we started in a buggy from Napier and drove some fourteen miles to Clifton, the picturesque and well-ordered homestead of the Messrs. Gordon, where we remained a short time for refreshment. Mr. G. F. Gordon gave us some interesting particulars about the Gannet "rookery" on his property that we were about to visit, and lent us horses for the trip along the coast. It was intensely hot, the thermometer registering 130° in the sun and 93° in the shade—undoubtedly the hottest day of the season. We rode about five miles along the beach, then left our horses and scaled the side of the cliff and crossed the slope beyond (a distance of about a mile altogether), and then we found ourselves right above the great Gannet nursery, to which we at once descended by a very narrow and slippery path along the face of the cliff. We were amply repaid for our trouble, for we happened to arrive at a fortunate time (just after sunset), when all the old birds had come in from their fishing, so that we were able to view the proceedings on the breeding-ground under the most favourable conditions.

Standing boldly out of the sea beyond the Cape are two conical "sugar-loaves" of Lower Miocene formation, and the cape itself presents a rounded headland with an arched passage right through it, which is distinctly visible from the decks of steamers following their usual track along the coast. From this headland the land rises in three little peaks, each successively higher, all of the same clay-marl formation, and then we come to a small plateau, about an acre in extent and about 200ft. above the sea, the whole of which is occupied by the Gannets. On each side of this little plateau the land slopes upwards. The actual breeding-ground is in the centre, which is perfectly level, and the birds occupy the higher ground for resting on, the whole surface being worn bare by the constant traffic over it. At the time of our visit there were probably over a thousand birds nesting there. Some of the nests contained sitting birds, there being only one egg in each nest; but by far the larger proportion contained young birds (never more than one) in all stages of growth, from the newly-hatched naked chick of a uniform black colour to the half-fledged nestling. But most of the occupants of the nesting-

ground were unfledged birds covered with a thick growth of down of snowy whiteness. These were to be seen all over the ground, either squatting beside an old bird that was incubating or strutting about the ground in a very important fashion. In the hollow I have described the nests were so crowded together that it was a matter of difficulty to step between them. The nests are carefully formed, looking like inverted shallow clay basins, with a depression in the centre filled with soft seaweed, and measuring about 18in. in diameter.

As I have said, we arrived just as the old birds had completed their fishing operations for the day. They were crowded close together on the rising ground on both sides of the nesting-place, each of them doubtless stewing in his crop a supply of fish to be regurgitated later on for the benefit of the young birds, who were manifesting the utmost impatience for their supper by a continuous "swirling" cry like that of young shags. We sat down about a dozen yards from the breeding-ground and watched operations with much interest for some time, without apparently causing any alarm to the birds, but, on our attempting to get nearer, the Gannets not actually sitting on the nests or attending to the young ones rose in a body and filled the air with the graceful sweeping of their black pinions. They were so closely packed together as they rose that it seemed to us quite a marvel that they could vibrate their wings so rapidly and at such close quarters without coming into actual contact with one another. Having once risen into the air, the birds continued their hovering overhead during the whole of our visit, and we could see them still on the wing, long afterwards, as we rode homewards along the beach. It was certainly a very pretty sight, and quite an unexpected one, for visitors at an earlier period of the day find only the incubators or the birds that happen to be at home performing their domestic duties. We walked boldly down into the breeding-ground and found that, as a rule, old birds sitting on newly-hatched chicks would not vacate their post of duty till compelled to do so, striking fiercely with their bills at the feet of any intruder. I switched one in the face with my pocket-handkerchief, but she showed fight and refused to leave the nest, so I left her there. I noticed that where the nest contained only an egg they were not so devoted, always rising in the air as soon as we had approached within a yard or two. There were many dead young birds strewed about the breeding-ground, in various stages of decomposition, and from these decaying objects there came an unpleasant smell, but there was nothing disagreeable in the nursery itself. Everything seemed well-ordered and under excellent discipline. In protecting its naked nestling the old bird would cover it up with her broad

webbed feet and press it down into the nest as if determined to stamp its young life out, but without any apparent injury to the chick, which was quite active and perky immediately on being released from this parental pressure. I did not come for specimens, but to inspect the breeding-place; however, before leaving I annexed a fine woolly nestling which was strutting about with the air of a lord chancellor, and this specimen I have much pleasure in exhibiting to you this evening. The rest of the birds, old and young, we left unmolested, and came away from Cape Kidnappers much pleased with the result of our visit, and, after a delightful drive in the cool evening air, arrived at Napier at 10 p.m. On our way along the beach we found a fledgling which had evidently fallen from the "rookery" and had floated a couple of miles down the coast, but was apparently still attended by the parents, for it was in excellent condition. From this bird I took the following notes:—

Fledgling.—Feathers appearing on the head, shoulders, and upper-surface of wings, lower part of back, breast, and sides of body of a slaty-black colour, each feather with a large triangular apical spot of white, even the secondaries and primary coverts being thus marked; bill and naked face brownish-black; legs blackish-grey with broad whitish lines down the tarsus and along the toes.

Œstrelata neglecta, Schl. (Schlegel's Petrel.)

I have in my collection a series of four (from Sunday Island, one of the Kermadec Group) which appear to bear out completely Mr. Salvin's view as to *Œstrelata leucophrys* (of Hutton) being only a condition of that species. They are all of pretty nearly the same size. No. 1 is in the ordinary uniform dark plumage of *Œ. neglecta.* No. 2 has whitish throat; breast, sides of the body, and abdomen white. No. 3 has the forehead and lores whitish; throat, sides of the head, and the whole of the fore-neck pale-grey and white intermixed, the former colour assuming the shape of small crescents on the cheeks and lower part of throat; feathers on vertex and crown with obscure, narrow margins of greyish-white; nape and hind-neck inclining to greyish-white, being paler than the rest of the upper-surface, but without any markings. No. 4 is in the perfect plumage of the so-called *Œ. leucophrys.* No one examining this series critically could come to any other conclusion than that they all represent one and the same species in various states of plumage.

Anas chlorotis, Gray. (Brown Duck.)

Hearing from Mr. Brough, of Nelson, of the capture of a "Crested Teal," I was naturally anxious to see it, and,

through his kind assistance, the specimen was sent over for my inspection. It turns out to be *Anas chlorotis* in a condition of partial albinism, the head being largely marked with white. But the curious thing is that, by a freak of nature, there is a well-developed "top-knot" of feathers on the hind part of the head standing fully half an inch above the surrounding plumage. This top-knot, which extends forward into a line with the eyes, is white, with some irregulars plashes of brownish-black, and the vertex and cheeks are also more or less variegated with white. The rest of the plumage is normal, the rounded spots on the breast and under-parts being particularly prominent, and the white edging on the speculum very conspicuous; and there is a creamy-white ring encircling the neck. (See Plate XI.)

Fuligula novæ-zealandiæ, Gmelin. (New Zealand Scaup.)

On the Papaitonga Lake a "Black Teal" brought out a brood of five young ones about the middle of December. The old bird was to be seen daily swimming about near the boatshed followed by her little family, huddled together in a clump as it were, and at the slightest appearance of danger the ducklings would instantly dive and reappear on the surface further out on the lake. Early one morning, on going down for a plunge in the water, I had an illustration of the force of maternal instinct in this bird. On opening the door of the boathouse leading to the spring-board I surprised the duck and her brood disporting themselves in the water only ten or twelve yards out. On my appearance the young birds instantly dived, whilst the old bird, evidently to divert attention from its brood, came swimming up to within a few feet of me with its mouth open and uttering a low cry. In the meantime the young had got to a safe distance under water, and then came to the surface again, when the parent, seeing that the apprehended danger was past, quietly joined them. On mentioning this circumstance to my son, he told me that he had witnessed a somewhat similar device on the part of the same bird only a short time before. On this occasion two sporting dogs took to the water and swam out in the direction of the young brood. The old duck at once rose in the air, flew up to the dogs, and kept circling round them, so as to distract their attention till the young birds were well out on the lake.

Hymenolæmus malacorhynchus, Gmelin. (Blue Duck.)

There is a nestling of this species in the Auckland Museum: Entire upper-surface olivaceous-brown, the down filaments being long and coarse; under-parts yellowish-white,

tinged with brown on the breast; sides of the face yellowish-white, with a conspicuous blackish-brown streak through the eyes; there is an obscure crescent-shaped mark of white behind each wing, and another of a more rounded form on each side of the croup. The tail consists of small feathers with downy filaments. Bill brown; under-mandible pale-yellow; legs yellowish.

Rhynchaspis variegata, Gould. (New Zealand Shoveller.)

Two partial albinoes of this species received from Lake Ellesmere are very remarkable and beautiful objects. No. 1 differs from the ordinary bird by the absence of the white cheek-mark, the head and neck being entirely black, with green metallic reflections. The whole of the breast—front, sides, and a narrow collar at the back—white, with scattered horse-shoe markings of dull chestnut-brown, the white being boldly defined against the black of the fore-neck, but on the lower margin it melts insensibly into the chestnut-brown of the sides and abdomen; large upper wing-coverts white, with broad crescentic bands of blackish-brown; the scapulars with a very broad stripe of white down the centre.

No. 2 has a dark head and neck, with green metallic reflections, but differs from the other in having the whole of the shoulders and scapulars pure white, there being only a dividing-strip of the normal colour down the spine; the long scapulary plumes are pale-blue on their outer and white on their inner vanes. The blue on the small wing-coverts presents a broad surface, and the angular patch of white between that and the speculum is very conspicuous. The dark colour of the head and neck is sharply defined against the white plumage below it. There is a large patch of pure white on each side of the croup, which has dark-green reflections; and the tail-feathers are greyish-white on their outer webs.

Eudyptes vittatus, Finsch. (Thick-billed Penguin.)

I obtained a specimen of this very rare Penguin at Stewart Island at the end of February last. The bird landed of its own accord in the little bay in which we were temporarily residing, and came hopping up the steep garden-path to the very door of the house, as if anxious to make the acquaintance of a practical ornithologist. It passed bravely through a group of tourists who were standing about, and snapped savagely at those who attempted to arrest its progress. I saw at a glance that it was not one of the common species, and, receiving my visitor with every expression of delight, speedily annexed him. Curiously enough, he allowed me to stroke his head without resistance, and later on submitted to be killed with the philosophy of a Penguin.

Eudyptes antipodum, Homb. and Jacq. (Yellow-crowned Penguin.)

There is a distinct tendency in this species to melanism. I had an opportunity of examining eleven specimens that were taken together, in a sort of breeding colony, on the Otago coast, near the Heads, last year. Several of them had scattered black feathers among the pure-white plumage of the under-parts, and in one of them I counted as many as nine jet-black feathers.

Apteryx haasti, Potts. (Haast's Kiwi.)

I have in my possession some interesting notes supplied to me by a collector who went to the West Coast some years ago specially in quest of this rare species. I have hitherto refrained from publishing those notes, from a desire to protect this Kiwi from the professional bird-hunter; although I fear such precautions are of little avail now against the inroad into our fair country, through official instrumentality, of stoats, weasels, and polecats. The last intelligence concerning the spread of these destructive animals is contained in a letter lately received by me from Mr. H. C. Field, C.E., of Wanganui (dated 9th December). He says, "My son Charles—who for several years past has been laying off and constructing roads for the Government in the country between the Tongariro Range and the Upper Wanganui—informs me that the weasels have become extremely numerous in the region where he has been working, and are destroying the Wood-pigeons wholesale. He says that, as those birds roost low down, among scrubby bush, the weasels climb up and attack them. He says that in walking through the bush he has constantly come across the remains of pigeons lying on the ground, and that, on examining those freshly killed, he found in every case that they had been bitten in the neck, so that the blood might be sucked out, after which the body was left. This pretty clearly indicates weasel's work. He tells me that, in consequence of this, the number of pigeons in that region has very perceptibly decreased during the last two or three years, and he believes that in a very few years more the birds will be extinct thereabouts. He thinks the weasels have come from the Auckland side, as he has heard that some were turned out in the Waikato for the purpose of destroying the rabbits. I am sure my son's information about the killing of the pigeons may be thoroughly relied on. No doubt other birds are being destroyed also; but the larger size and more conspicuous colour of the pigeon renders their remains more noticeable." If perching birds suffer to this extent, how must it fare with Kakapos, Kiwis, and Woodhens? That all these flightless

species are doomed to rapid extinction goes without saying, and every lover of natural history will therefore learn with delight that, under the direction of the Otago Acclimatisation Society, Resolution Island is now being stocked with all these vanishing forms, so that there is yet a chance of a remnant being preserved for the naturalist of the future. The Little Barrier Island having recently been taken over by the Auckland Acclimatisation Society, we may look for excellent work there also.

But to return to *Apteryx haasti*. I elicited from my collector one very singular fact: on the western watershed of the Heaphy Range, where, as a rule, *Apteryx haasti* alone is found, the loose ground is inhabited by a very large earthworm, on which this species principally feeds. On the eastern side, where the Grey Kiwi (*Apteryx oweni*) abounds, the large earthworm is not to be found, its place being supplied by a very small earthworm, on which this species seems exclusively to subsist. The summit of the main range—say a tract about a mile in width—distinctly divides the range of one species from that of the other. May not this remarkable difference in the natural food-supply have influenced the development of these two closely-allied species in divergent lines—the one being now distinguished by its massive skeleton and robust proportions, and the other by its slender structure and generally feeble development? The general style of the plumage is the same in both, it being easy, in a sufficient series of specimens, to trace a gradation from the dappled-brown plumage of *Apteryx haasti* to the dappled-grey plumage of *Apteryx oweni*.

Apteryx lawryi, Rothschild. (Stewart Island Kiwi.)

On the 21st February I killed a pair of *Apteryx lawryi* received from Stewart Island. Although the birds had been in captivity for six weeks, and had lost all their fat, the male weighed 5½lb. and the female 7¼lb.

The following measurements were taken from the specimens before being skinned:—

Male.—Extreme length, to end of tail 26in., to end of outstretched legs 36in.; rudimentary wing, 1in.; terminal claw, following curvature, 0·25in.; bill, along the ridge 4·56in., along the edge of lower mandible 5·25in.; tarsus, 3in.; middle toe and claw, 3·5in.; hallux, 0·6in.; circumference of tarsus, in the middle 2·25in., at the junction of the toes 4·2in.

Female.—Extreme length, to end of tail 30in., to end of outstretched legs 39·5in.; rudimentary wing, 1·5in.; terminal claw, following curvature, 0·5in.; bill, along the ridge 6·75in., along the edge of lower mandible 7·25in.; tarsus,

3in.; middle toe and claw, 3·5in.; hallux, 0·75in.; circumference of tarsus, in the middle 2·4in., at the junction of the toes 4·25in.

Externally the sexes are alike, except as to size. Both specimens exhibited in the bill a slaty-black upper-surface, but in younger examples I have noticed that it is horn-coloured. The thighs are of great size and strength, testifying to the bird's power of rapid locomotion. In the female, which is appreciably the larger bird, the thighs would weigh each, I suppose, not less than a pound.

I obtained some interesting particulars from Mr. Marklund, by whom these two large Kiwis and about a dozen others were collected. He says that the bird is very scarce, and has to be hunted for over a large extent of country. Its favourite feeding-ground is the summit of Table Hill, rising to an elevation of 2,300ft., which is covered with grass and stunted vegetation, and in the daytime it has to descend some 500ft. in order to camp in the bush, the summit not affording sufficient covert. He has never found any on the western slope of Table Hill below a level of 1,000ft.; but on the eastern side the Kiwis go right down to the plain, or practically to the level of the sea. He has found them inhabiting holes among the roots of the "mutton-bird woods."

He generally found a pair of birds together in one hole, sometimes accompanied by a single young one. On one occasion he found five birds inhabiting an extensive chamber. Being without provisions, he had to cook and eat them, rare as he knew the bird to be. From the retreat of this party of five to the summit of Manuka Flat (a distance of half a mile) there was a broad beaten track, as if sheep had been accustomed to travel over it. The roots crossing this track were so worn and abraded that he came to the conclusion the Kiwis had been using the path continuously for several years. He says that this species has three distinct calls: one is a loud shrill whistle, especially in fine evenings when the atmosphere is clear; the second is a deep rasping note, seldom heard; and the third is a low clucking sound, rarely uttered. In hunting these birds his plan was to start about 3 a.m., before daybreak, while the scent was strong upon the ground, and then to intercept them on their way from their open feeding-grounds to the shelter of the "mutton-bird woods," or track them by means of the dog to their holes. The old birds often make a stubborn resistance, and the first time his dog tackled one of them he got his foreleg ripped up about six inches by the bird's claws.

Apteryx lawryi is very rare in collections, both here and at Home, and I should have been glad for Mr. Marklund to

procure more of them before he went to Australia, but, the provisions of the Wild Birds Protection Act having been extended to Kiwis in general, I wrote warning him to take no more. There is a chance of this bird being preserved in Stewart Island, which has happily escaped the introduction of stoats and weasels, but on the mainland the protection comes too late, both for the Kiwi and the Kakapo.

In the same hole with the very large example forwarded to me there was a nestling, apparently only a few days old, from which I have been enabled to furnish a description of the species in that stage.

Young.—Head, throat, and under-parts generally greyish-brown, the disunited filaments of the feathers imparting a hairy-like appearance to the plumage; on the hind-neck these filaments assume a more arrow-head appearance, the plumage being at the same time very fluffy; upper-surface generally tawny-brown, with yellowish-brown shaft-lines, the latter being a distinctive feature; bill and feet pale-brown.

The adult, as already stated, resembles very nearly in its plumage *Apteryx mantelli* of the North Island; but the young is very different to that of the latter species, being far more like that of *Apteryx australis*.

Half-grown bird (probably a year or eighteen months old). —Plumage similar to that of adult, but with more chestnut-colour in it; feathers covering flanks with shining amber-coloured shafts; bill, 3in.

Towards the end of November Mr. Marklund obtained two eggs of this species of Kiwi, after nearly a month's continuous search; but it was so late in the season that, in both cases, the chick was fully formed within the shell, and had to be removed by incision. This somewhat damaged the specimens, but I am nevertheless able to give a full description of them. They differ conspicuously both in size and in contour. The larger one measures 5·4in. in length by 3·25in. in breadth, and is perfectly elliptical in shape, there not being the least indication of a smaller end. The other egg is smaller, measuring 5·1in. by 3·1in., and is narrower at one end. Both of them are of a very pale green colour, or perhaps, more properly speaking, greenish-white, and the shell, especially in the smaller egg, exhibited minute, widely-scattered punctæ on the surface, distinctly visible under a magnifying glass, and similar to the markings on the eggshell of the Moa. In forwarding the specimens, my collector says: "I had a very hard job in procuring these eggs, as the birds do not go far away from their nests while hatching, and of course the dog got a very poor chance of picking up the scent. One of the eggs was somewhat damaged, through the bird defending it from the dog, before I could reach the place; nevertheless

it has a good show-side. The larger of the two I procured in a locality where I had never been before, and, owing to the dog being muzzled, the bird that was sitting on the egg managed to escape; and, inclement weather coming on, it was impossible to get another specimen before I had to leave. In the breeding season the birds never come out on the open ground—in fact, they seem to be starving themselves in their fear of leaving the nest or its close vicinity."

Apteryx bulleri, Sharpe, Trans. N.Z. Inst., vol. xxi., p. 224.

There can be no doubt that there are two forms of *Apteryx* inhabiting the North Island—one chestnut-brown in colour, the other blackish-brown—as easily distinguishable by their plumage as the Brown Woodhen and the Black Woodhen. The specimen which I have the pleasure of exhibiting this evening (a fine male bird) is wholly brownish-black, being the darkest I have seen. This, with six others of both sexes, came from the Waitara district, where, so far as I can learn, all the birds are of dark colour. My specimens exhibit different shades of colour, and in some of them the brown predominates; but they present a very different appearance to the ordinary bird, and, in addition to this distinctive feature, the plumage is more wiry in structure, with stiffened points. Sir James Hector was the first to call my attention, some years ago, to the existence of this darker race, telegraphing to me from Gisborne to examine a live pair passing through Wellington on a homeward-bound ship; but I was anxious to see a good series of specimens before attempting to differentiate it. As readily distinguishable from the typical chestnut-brown Kiwi, it ought to have a name, and I think we must adhere to the one imposed by Dr. Sharpe. His distinguishing characters for *Apteryx bulleri* as compared with *Apteryx australis*—"blackish-brown instead of a tawny tint," and "the curious harsh structure of the plumage, especially of the feathers of the rump and neck"—are far more applicable to this bird than to the lighter and better-known form, which will still retain the name of *Apteryx mantelli*.

Art. XIV.—*The* Stenopelmatidæ *of New Zealand.*

By Captain F. W. Hutton, F.R.S.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1896.*]

Plates XII.-XIII.

The *Stenopelmatidæ* are a small but important family of he *Locustodea*, distinguished by their long maxillary palpi and compressed tarsi, which have no lateral lobes. None of the New Zealand species show any trace of elytra, or wings. They are widely spread over the warmer parts of the earth; few, however, are known from South America, and none from Polynesia east of New Guinea and New Caledonia. They appear to be more numerous and more varied in New Zealand than in any other part of the world, for about thirty species, included in twelve genera, are recorded in this paper, and no doubt several others remain to be discovered.* Here they are generally known by their Maori name of *weta*.

The family can be divided into two well-marked sub-families—the *Anostostominæ*, with pads on the lower surfaces of their tarsi, and the *Dolichopodinæ*, without any pads. Each of these sub-families can again be broken up into two groups—the former by the presence or absence of auditory pits on the fore tibiæ, and the latter by the nature of the movable spines which generally occur on the apices of the femora.

The wetas are nocturnal insects, and are not abundant. Even in New Zealand, although common in places, they cannot always be found when wanted, and this will partly account for our ignorance of their habits. They are generally found in the forest, either climbing trees, or boring into the trunks, or hiding under loose bark or among fallen and rotten wood; a few, however, live underground or under stones. Most of them are solitary, but the cave-wetas live together in considerable numbers. All appear to climb well, but the larger species of *Anostostominæ* have almost lost the power of jumping; the *Dolichopodinæ*, however, hop and run swiftly.

According to Mr. J. G. O. Tepper, the food of these animals consists mainly, if not entirely, of self-caught insects.†

* Tepper gives New Zealand as a locality for *Anostostoma australasiæ*, but I think this must be a mistake.

† "The *Gryllacridæ* and *Stenopelmatidæ* of Australia," Trans. Roy Soc. S. Australia, 1892, p. 172.

In New Zealand, however, they are generally thought to be vegetable feeders; and, indeed, this has been proved to be the case with a species of *Hemideina* by Mr. Brough, who kept one alive in captivity and fed it on nuts and bark;* also, it is difficult to see what animals the cave-wetas could catch.

The colours are usually some shade of brown—yellowish or reddish or purplish—and variety is obtained by darker and lighter shades.

Two different kinds of sounds are made by species of *Hemideina*. The first is called by Mr. J. Brough "a chattering kind of sound," emitted at night; a sound which he had often heard at night in the woods. Sir W. Buller states that *Hemideina thoracica* makes, when disturbed, a clicking noise, accompanied by a slow alternate movement of its powerful hind legs.† Mr. Hudson says of *H. megacephala*, "Both sexes when irritated emit a peculiar grating sound, which may be often heard at night in the forest, and is produced by the friction of the (hind) femur against a small file situated on each side of the second abdominal segment."‡ The sounding-organ here referred to consists of six or seven oblique, parallel, dark ridges near the lower margin of the second abdominal tergum, on each side (Plate XII., fig. 4*b*), and is equally developed in both sexes. There is nothing on the inner surface of the hind femur to correspond with this organ, but possibly the inner lower edge may be sufficiently sharp to make the file sound. The hind coxæ are too distant. I confess I do not see clearly how the sound can be made, and if it had not been for Sir W. Buller's observations I should have looked to the apical spines of the middle tibiæ for the striking instrument.

The genus *Deinacrida* has the same sounding-file, but it is reduced to one or two ridges. In *Onosandrus* there is no sounding-file, but several of the lobes of the anterior abdominal terga are roughened, and this may act as a sound-producing organ; however, I am not aware of any one having heard it. Mr. Brough also says of his captive *Hemideina*, "I found that he could bite fiercely, and when excited could hiss like an adder." This seems to be a different kind of sound from the other, and may be confined to the males. All those wetas which are known to make sounds possess well-developed auditory organs in the fore tibiæ, and, as they make the sounds at night, we may suppose that they are calling to each other, notwithstanding the fact that the organ is similar in

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* Trans. N.Z. Inst., vol. xxviii., p. 386.
† Trans. N.Z. Inst., vol. iii., p. 35.
‡ "Manual of New Zealand Entomology," London, 1892, p. 118.

both sexes. The *Dolichopodinæ* have no auditory organ, and, apparently, they emit no sounds.

The value of this paper has been much enhanced by the kindness of the Rev. W. Colenso, F.R.S., in sending me the types of his species for examination; but it by no means pretends to be a complete monograph of our wetas. On the contrary, several points of nomenclature are left in a very unsatisfactory state, which can only be improved by a re-examination of types. The paper will, however, be useful in pointing out where our information is defective; it will, possibly, be the means of preventing a further growth of synonyms; and it will also enable field naturalists to name with tolerable exactness the wetas they may have observed. The cave-wetas are in the greatest confusion, and we do not know whether there are six or only two species. I should be very glad of any specimens that may be sent me. They may be dried and placed between pieces of linen, or they may be put into formolin or alcohol. They should not be pinned, as that destroys the sternum.

Sub-family ANOSTOSTOMINÆ.

Body nearly straight, broadest at the head or pronotum. Antennæ distant at their bases, the fastigium passing between them. Clypeus divided into post-clypeus and ante-clypeus. Pronotum transverse; mesosternum and metasternum bilobed. Abdomen longer than the thorax, very slightly compressed. Ovipositor tapering. Hind tibiæ with three pairs of apical spines, one superior and two inferior. Tarsi with pads on the lower surface, two on the first joint and one each on the second and third joints.

Some of the genera have a pair of large oval auditory pits on the proximal half of the fore tibiæ, one on each side, while in others there are no auditory pits. Most, if not all, have a sounding-organ on each side, near the lower margin of the second abdominal tergum. True ocelli are absent in all the New Zealand species known to me, but in a few there is an indistinct ocelliform spot on the fastigium.

SYNOPSIS OF THE GENERA.

Group ANOSTOSTOMÆ (with auditory pits on each side of the fore tibiæ).

Genus *Deinacrida*.

Fastigium sulcate above. Prosternum with two sharp spines. Fore femora with one, mid and hind femora with two, small apical spines. Mid tibiæ with two pairs of apical spines. Fourth joint of the hind tarsi longer than the other three together.

Genus *Hemideina*.

Fastigium foveolate above. Prosternum unarmed. Fore femora without apical spines; mid femora with one apical spine, or none; hind

femora with two apical spines or one, or none. Mid tibiæ with a pair of inferior and only one superior apical spines. Fourth joint of the hind tarsi shorter than the other three together.

Group MIMNERMI (without any auditory pits on the fore tibiæ).

Genus *Onosandrus.*

Fastigium broad, not sulcate nor foveolate. Femora without apical spines. Fore and mid tibiæ with two pairs of apical spines. Hind tibiæ slender, armed above with two rows of small spines and a pair of large subapical spines in addition to the apical spurs.

Genus DEINACRIDA, White. (1842.)

Form large and robust. Head distantly punctured; fastigium Y-shaped, low and narrow between the antennæ, broadening and grooved above, passing gradually below into the front. No ocelli. Antennæ with the first joint large, subcylindrical; the second about half the length of the first, not swollen; the third nearly as long as the first, cylindrical, thinner than the second; the rest small. Eyes ovate. No ridges between the front and the genæ. Pronotum transverse, not projecting over the occiput; anterior and posterior margins nearly straight; the lobes short and rounded, not descending much beyond those of the mesonotum; the surface roughened.

Sternum broad; prosternum with two sharp spines; meso- and meta-sterna bilobed. Legs stout, the hind tibiæ two and a half to three times the length of the pronotum. Coxæ of the fore and hind legs as widely separated as those of the middle legs; those of the fore and middle legs spined. Fore femora with a minute apical spine on the inner (anterior) side. Mid and hind femora with a pair of apical spines. Fore and middle femora flattened below. Hind femora not much dilated, roundly angled above near the insertion; flattened below, and armed with two rows of strong spines. Fore and middle tibiæ with two pairs of apical spines, about equal in length. Hind tibiæ flattened above, and spined both above and below. Apical spines, three pairs, the two upper of which are subequal, the lower pair much smaller; the two lower pairs are articulated and movable. Second joint of the hind tarsi with a single blunt spine above; third joint nearly as long as the second; fourth joint longer than the other three together. Genitalia: Subgenital plate of male transverse, the posterior margin deeply concave between the insertions of the styles, the lobes carrying the styles very prominent; supra-anal plate rounded, the anal valves with a short black point on the outer margin of each, near the apex. Cerci short and stout. Subgenital plate of the female triangular, short, notched at the apex. Ovipositor slightly compressed at the apex, depressed at the base.

In the female the spines on the prosternum are further apart than in the male, and the head and thoracic nota are smoother. It is generally rather larger than the male, and the legs are proportionally shorter.

Locality.—New Zealand only.

KEY TO THE SPECIES.

Mid femora without spines below; post-margins of abdominal terga smooth:	
Fourth to eighth abdominal terga not emarginate ..	*D. heteracantha.*
Fourth to eighth abdominal terga emarginate posteriorly	*D. parva.*
Mid femora with spines below; post-margins of abdominal terga granulated	*D. rugosa.*

Deinacrida heteracantha. Plate XII., figs. 1–1*c*.

Deinacrida heteracantha, White, in Gray's Zool. Misc., 1842, part 2, p. 71; Dieffenbach's New Zealand, ii., p. 280; Zool. Voyage of "Erebus" and "Terror," Insects, p. 24, pl. 5, figs. 1, 1*a*, and 1*b*; Hochstetter's New Zealand, p. 169, wood-cut; Buller, Trans. N.Z. Inst., vol. iii., p. 35, and Zoologist, 1867, p. 849; Brunner, Mon. Stenopelmatides, p. 25. *Hemideina gigantea*, Colenso, Trans. N.Z. Inst., vol. xiv., p. 278 (1882).

Antennæ five or six times the length of the body. Front slightly wrinkled; post-clypeus very short; labrum nearly circular; mandibles not conspicuously keeled. Pronotum margined, symmetrically rugose, the lateral furrows smooth, the transverse furrow obsolete. Meso- and meta-nota slightly margined, transversely wrinkled on the posterior portion. Thoracic sterna smooth and shining, the lobes of the mesosternum produced into sharp spines, those of the metasternum into blunt spines. Abdominal segments slightly transversely striated above near their posterior margins, and, in the male, they are obscurely keeled from the fifth to the eighth. Fore and middle femora unarmed below. Hind femora, below, with four to seven strong spines on the outer and seven to twelve on the inner edge. Fore and middle tibiæ with four pairs of spines below; the middle tibiæ have also two spines above on the posterior side. Hind tibiæ, above, have four alternating spines in each row, the inner larger (occasionally a fifth is developed); below they have four spines in the inner and five in the outer row.

The sounding-organ is a single oblique ridge on each lobe of the second abdominal tergum.

In the female the abdominal segments are more strongly keeled above than in the male. The keel is most prominent on the fifth and sixth segments; the second and third segments are slightly emarginate, posteriorly, above.

Colours.—Pale tawny, the pronotum reddish, without any dark marks on the thoracic nota or tarsi; mandibles pale in colour. In the female the abdominal segments are dark-purplish on the posterior margins.

Average dimensions are: Length, 55mm.; length of pronotum, 15mm.; of thorax, 25mm.; of abdomen, 30mm.; of fore tibia, 28mm. ♂, 23mm. ♀; of hind tibia, 48mm. ♂, 42mm. ♀; of hind femora, 40mm. ♂, 36mm. ♀; of ovipositor, 28mm. Width of head, 13mm.; of pronotum, 17mm.

Localities.—The northern part of the North Island and the Great Barrier Island.

This species is the weta-punga of the Maoris. Sir W. Buller says that it appears to subsist chiefly on the green leaves of trees and shrubs. It climbs with great agility, and is sometimes found on the topmost branches of lofty trees, but generally on the low underwood of the forest. Dr. Hochstetter says that it lives in rotten wood and under the bark of trees.

Deinacrida rugosa. Plate XII., fig. 2.

Deinacrida rugosa, Buller, Trans. N.Z. Inst., vol. iii., p. 36, pl. v*b*., figs. 1 and 3 (1871).

Antennæ less than twice the length of the body. Front smooth; post-clypeus slightly transversely wrinkled, and the lateral margins swollen. Abdomen very thick and rounded. Pronotum margined. Meso- and meta-nota and abdominal terga roughened, their posterior edges ornamented with a row of granules; the abdominal terga, especially from the second to the fourth, slightly emarginate. Lobes of the meso- and meta-sterna not produced into spines. Middle femora, below, with three spines on the inner (posterior) edge; hind femora, below, with five strong spines on the outer (anterior) and five or six on the inner (posterior) edge. Tibiæ of fore and middle legs with four pairs of spines below, those of the middle legs with two spines above on the posterior edge; hind tibiæ, above, with four spines in each row, the inner considerably larger than the outer; below there are three spines in the inner and four in the outer row. The superior pair of apical spurs are fixed.

The sounding-organ on the second abdominal tergum consists, on each side, of two oblique ridges.

In the female the emarginations of the abdominal terga are not so distinct. The subgenital plate is long and truncated at the apex.

Colours.—Reddish-brown, meso- and meta-nota and the posterior margins of the abdominal terga darker. Mandibles pale, with black tips. Thoracic nota and tarsi with black marks. A blackish line on the upper surface of the tibiæ.

Length, 51mm. ♂, 58mm. ♀; of pronotum, 12mm.; of thorax, 23mm.; of abdomen, 29mm. ♂, 35mm. ♀; of ovipositor, 25mm.; of fore tibia, 15mm.; of hind tibia, 30mm.; of hind femur, 29mm. Width of head, 12mm.; of pronotum, 17mm.

Localities.—The type came from Wanganui, and was found underground. The foregoing description is taken from a pair from among stones on the beach at Stephens Island, in Cook Strait, presented to the Canterbury Museum by W. T. L. Travers, Esq.

Deinacrida parva.

Deinacrida parva, Buller, Trans. N.Z. Inst., vol. xxvii., p. 147 (1895).

I have not seen this species. It is said to be near *D. rugosa*, but the mid femora have no spines below, and the abdominal terga are deeply emarginate. Ochre-yellow, the pronotum dull reddish-brown. Length, 28mm.; of hind tibia, 20mm.

It comes from the Nelson Provincial District.

Genus Hemideina, Walker. (1869.)

Form large and robust, not less than an inch in length. Head smooth, often very large in the male. Fastigium rounded between the antennæ, flattened and foveate in the region of the ocellus, which is obsolete. Antennæ short, separated at their bases; first joint long and thick; the second shorter, cylindrical; the third longer than the second but shorter than the first; the rest small. Eyes pyriform. Usually a ridge (frontal ridge) between the front and the gena, running from the eye to the base of the mandible (not well marked in the female). Pronotum smooth, otherwise as in *Deinacrida*. Pro-sternum unarmed; lobes of the meso- and meta-sterna short and rounded. Legs stout, the hind tibiæ two or three times as long as the pronotum. Coxæ widely separated from each other, those of the first pair spined. Femora of fore legs without any apical spines, those of the middle legs with one, and those of the hind legs with two small apical spines, or with none. Fore and mid femora convex below, hind femora only slightly dilated, angled above near the insertion. Fore tibiæ usually with two pairs of apical spines. Mid tibiæ with an inferior pair and a single superior apical spine. Hind tibiæ flattened above, and with a few spines on each side, as well as some below; the apical spurs are three pairs, all of which are fixed; the superior pair is much longer than the others. Second joint of the hind tarsi with a single blunt spine above; the fourth joint shorter than the other three together. Genitalia: Subgenital plate of male nearly square, the posterior

margin straight or hollowed, the lobes carrying the styles slightly prominent. Supra-anal plate rounded. Cerci moderate. Subgenital plate in the female triangular, with the apex truncated or notched. Ovipositor as in *Deinacrida*.

The head of the male is variable in size. In the young the hind tibiæ are proportionally much thicker than in the adult. The colourless ante-clypeus is membranous, and can be partly folded inwards, carrying the labrum with it; this alters much the appearance of the face.

Localities.—New Zealand, Eastern Australia, and Lord Howe's Island.

KEY TO THE SPECIES.

a. Middle tibiæ without spines above; hind tibiæ, above, with 4 spines in the inner row.
- *b.* Hind tibiæ, above, with 3 spines in the outer row.
  - *c.* Fore tibiæ, below, with 4 spines in each row .. .. *H. armiger.*
  - *cc.* Fore tibiæ, below, with 3 spines in each row .. .. *H. thoracica.*
- *bb.* Hind tibiæ, above, with 4 spines in the outer row.
  - *c.* Fore tibiæ, below, with 3 spines in each row .. .. *H. producta.*
  - *cc.* Fore tibiæ, below, with 3 in outer and 4 in inner row .. .. *H. abbreviata.*
  - *ccc.* Fore tibiæ, below, with 4 spines in each row.
    - *d.* Pronotum dark coloured .. .. *H. megacephala*
    - *dd.* Pronotum pale with dark markings .. *H. figurata.*

aa. Middle tibiæ with a spine above; hind tibiæ, above, with 5 spines in the inner row.
- *b.* Middle femora with spines below .. .. *H. femorata.*
- *bb.* Middle femora unarmed below.
  - *c.* Middle femora with a single apical spine *H. ricta.*
  - *cc.* Middle femora without any apical spines.
    - *d.* Pronotum blackish, margined with tawny .. .. *H. maori.*
    - *dd.* Pronotum tawny, margined with blackish .. .. .. *H. broughi.*

Hemideina megacephala. Plate XII., figs. 3–3c.

Deinacrida megacephala, Buller, Zoologist, 1867, p. 850; Trans. N.Z. Inst., vol. iii., p. 36, pl. *vb.*, fig. 2; Hudson, Man. N.Z. Entomology, pl. 17, fig. 8, and pl. 18, fig. 2. *Hemideina capitolina*, Walker, Cat. Dermaptera Saltatoria in the British Museum, part i., p. 161 (1869). *Deinacrida ligata*, Brunner, Monog. d. Stenop. and Gryll. in Verh. k. k. Zool. and Bot. Gesellsch., Wien, 1888, p. 24.

Head in the adult male very large. Front of epicranium smooth; frontal ridges curved outwards, rugose; a deep depression under each antenna; post-clypeus transversely wrinkled, separated from the ante-clypeus by a distinct ridge; labrum ovate; mandibles very long, not conspicuously keeled in front. Legs: Fore and middle femora without any spines

below; hind femora, below, on the outer edge, with three strong spines, followed by two or three small ones, and several minute spines on the inner edge; above there are from seven to ten minute spines, more or less rudimentary. Fore and middle tibiæ without any spines above, and the posterior superior apical spine of the fore tibiæ is sometimes missing. Below the fore tibiæ have four spines in each row, while the middle tibiæ have four in the outer (anterior) and two or three in the inner (posterior) row. Hind tibiæ, above, with four spines in each row, below there is a subapical pair, followed by two single spines. The subgenital plate in the male is longer than broad, and the apex, between the insertions of the styles, is straight. In the female the apex of the subgenital plate is retuse, or notched. In the female the head is smoother, there are no depressions under the antennæ, and no transverse ridge on the clypeus.

Colours.—The pronotum is brown, almost black in the young, with a thin, pale, longitudinal line, which is continued on the other thoracic nota and on the occiput. The mesonotum is generally paler than the rest of the body. The abdominal segments, above, are banded anteriorly and posteriorly with dark-brown, and usually there is a broad dorsal longitudinal stripe of the same colour in both sexes.

Length, 40mm.; of head, 28mm. ♂, 15mm. ♀; of pronotum, 9mm.; of thorax, 18mm.; of abdomen, 20mm.; of ovipositor, 21mm.; of fore tibia, 17mm.; of hind tibia, 21mm. ♂, 26mm. ♀; of hind femur, 22mm. ♂, 25mm. ♀. Width of the head, 13mm. ♂, 9mm. ♀; of pronotum, 12mm.

Localities.—Wellington; Stephens Island, in Cook Strait; Pelorus Valley; Westland; Lord Howe's Island (Brunner).

A common species, generally found among dead wood or in the hollow stems of old trees. Mr. Hudson says that *Melicytus ramiflorus* is a favourite tree, whose stems may often be seen pierced with large holes, out of which the insects emerge at night to feed on the leaves. They are strictly arboreal in their habits, exhibit great skill in walking along branches, and will climb up a thin stick with wonderful rapidity.*

Hemideina figurata.

Hemideina figurata, Walker, Cat. Dermaptera Saltatoria in the British Museum, part i., p. 162 (1869). *Hemideina tibialis*, Walker, *l.c.*, p. 164 (Young).

I have not seen this species. It appears to be distinguished from *H. megacephala* only by the colour of the pronotum. Probably it should be considered as a variety of that species.

Locality.—Wellington (Earl).

* "Manual of New Zealand Entomology," London, 1892, p. 113.

Hemideina armiger.

Deinacrida armiger, Colenso, Trans. N.Z. Inst., vol. xvii., p. 155 (1885). *Hemideina nitens*, Colenso, *l.c.*, vol. xxi., p. 193 (1889).

The head in the male is large, but narrower than in *H. megacephala*, to which it is closely allied. The fastigium is narrow and the fovea obsolete. The genæ are more rugose than in *H. megacephala*, and the front of the epicranium, as well as the post-clypeus, is transversely wrinkled. The frontal keels are curved outwards and rugose. The male has a deep depression under each antenna, and a transverse ridge across the clypeus. The labrum is ovate, and the mandibles are not conspicuously keeled in front. The spines on the femora and on the fore and middle tibiæ are the same as in *H. megacephala*. Hind tibiæ, above, have three spines in the outer and four in the inner row, the spines being longer than in *H. megacephala*; below there are a pair of subapical spines, followed by two single spines.

The subgenital plate in the male is like that in *H. megacephala*, but in the female it is slightly truncated, not notched, at the apex.

Colours.—The pronotum is pale, with dark markings in the depressions. The abdominal segments, above, are banded anteriorly and posteriorly with brown, paler than in *H. megacephala*. There is no longitudinal dorsal dark band in either sex. The female is darker in colour than the male.

Length, 40mm.; of head, 25mm. ♂, 11mm. ♀; of pronotum, 6mm.; of thorax, 13mm.; of abdomen, 24mm.; of ovipositor, 19mm.; of fore tibia, 15mm.; of hind tibia, 25mm.; of hind femora, 22mm. Width of head, 11mm. ♂, 8mm. ♀; of pronotum, 9mm.

Localities.—Wairoa and Forty-mile Bush, in Hawke's Bay; Manawatu, in Wellington Provincial District.

I have examined four males and three females, including the Rev. W. Colenso's types, and find the characters to be constant.

Hemideina thoracica.

Deinacrida thoracica, White, Voy. "Erebus" and "Terror," Insects, pl. 5, figs. 2, 2*a*, 1*c* (1846), no description; Buller, Zoologist, p. 850 (1867); Brunner, *l.c.*, p. 24.

A female in the Museum has the fastigial fovea elongate; slight depressions under the antennæ; the frontal ridges straight and low; the labrum slightly ovate. The fore and middle femora have no spines below; the hind femur has two strong spines followed by some minute ones on the outer edge. The fore and middle tibiæ have each two pairs of apical spines, and none above; below the fore tibiæ have

three spines in each row, the middle tibiæ four in the outer and three in the inner row. The hind tibiæ, above, have three spines in the outer and four in the inner row; below there are the usual subapical pair, followed by two single spines. The subgenital plate is truncated at the apex.

The colour is pale ochraceous with dark markings on the pronotum. Head and hind tibiæ dark-chestnut.

Length, 33mm.; of head, 12mm.; of pronotum, 7mm.; of thorax, 14mm.; of abdomen, 19mm.; of ovipositor, 18mm.; of fore tibia, 13mm.; of hind tibia, 21mm.; of hind femur, 21mm. Width of head, 7mm.; of pronotum, 9mm.

Locality.—Auckland.

According to Sir W. Buller, this species lives in decayed wood, particularly the dried stems of the tutu (*Coriaria ruscifolia*) and the branches of *Griselinia lucida*, into which it bores. No complete description has as yet been published.

Hemideina producta.

Hemideina producta, Walker, Cat. Derm. Salt. in B.M., p. 163 (1869). *Hemideina abbreviata*, Walker, *l.c.*, p. 163 (1869).

I have not seen this species. According to the description, it differs from *H. thoracica* in the hind tibia having four spines in each row above, and in the colours, the hind borders of the abdominal segments being piceous. *H. producta* is said to have three spines on each side below in the fore and middle tibiæ, while *H. abbreviata* is said to have four in the outer and three in the inner row. *H. abbreviata* is also said to have been captured in a cave by Mr. H. Drew, but as no one else has found a specimen of *Hemideina* in a cave this may perhaps be a mistake.

Locality (?), probably the North Island.

Hemideina femorata, sp. nov. Plate XII., figs. 4–4*b*.

Head in the male not very large; front and post-clypeus transversely wrinkled, the genæ granulated below. The fastigium is narrow, the fovea slight and elongated. The frontal keels are straight from the eye to the mandible. The post-clypeus is shorter than the ante-clypeus, the two portions being divided in the male by a slight ridge. The mandibles in the male are sharply keeled anteriorly, and project much in front of the clypeus. Labrum nearly circular. The pronotum has the margins of the lateral lobes horizontal, straight, slightly rounded at the corners. Fore femora unarmed below; middle femora, below, with two or three sharp spines near the apex on the outer (anterior) edge; hind femora with two to four sharp spines below, near the apex, on the outer edge, none on the inner; above there are from six to ten minute but sharp spines. Fore tibiæ, below,

with four spines in each row; middle tibiæ, below, with four spines in the anterior and three in the posterior row; above there is a single spine on the posterior side beyond the middle. Hind tibiæ, above, with four spines in the outer and five in the inner row; below there are the usual subapical pair, followed by two single spines on the outer side. The subgenital plate in the male is longer than broad, and concave at the apex between the insertions of the styles. In the female the head is smaller, and the genæ are smoother. The subgenital plate is very slightly notched at the apex.

Colours.—Head chestnut-brown, darker in the male. Pronotum and mesonotum pale-tawny, with dark-brown markings; a thin, pale, longitudinal line on the thoracic nota and on several of the abdominal terga. Abdominal segments, above, pale-tawny with broad posterior and narrow anterior dark-brown borders.

Length, 40mm.; of head, 18mm. ♂, 12mm. ♀; of pronotum, 8mm.; of thorax, 16mm.; of abdomen, 23mm.; of ovipositor, 15mm.; of fore tibia, 13mm.; of hind tibia, 20mm.; of hind femur, 20mm. Width of head, 11mm. ♂, 9mm. ♀; of pronotum, 11mm.

Localities.—Manawatu, Wellington District; and Banks Peninsula.

I have examined two males and eleven females of this species. It is easily recognised by the spines on the lower surface of the middle femora.

Hemideina ricta, sp. nov.

This species closely resembles the last, but differs from it in the following particulars: The head of the male is larger; the front and post-clypeus are rugose (not wrinkled), and the genæ are smoother. The post-clypeus is longer than the ante-clypeus, the two portions not separated by a ridge. Middle femora without any spines below.

Length, 40mm.; of head, 22mm. ♂, 11mm. ♀; of pronotum, 8mm.; of thorax, 17mm.; of abdomen, 20mm.; of ovipositor, 17mm.; of fore tibia, 14mm. ♂, 11mm. ♀; of hind tibia, 21mm. ♂, 17mm. ♀; of hind femur, 21mm. ♂, 18mm. ♀. Width of head, 13mm. ♂, 7mm. ♀; of pronotum, 13mm. ♂, 10mm. ♀.

Localities.—Banks Peninsula and South Canterbury.

I have examined two males and five females of this species.

Hemideina maori.

Deinacrida maori, Pictet et Saussure, Bull. de la Soc. Entomol Suisse, vol. viii., p. 296., pl. 1, fig. 2 (1891).

This species is smaller than any of the foregoing. The following description and measurements are taken from a pair

of co-types presented to the Canterbury Museum by Mr. H. Suter, the discoverer of the species:—

Fastigium broad, the fovea shallow. The lateral margins of the lobes of the pronotum are oblique, ascending posteriorly. The fore and middle femora have no apical spines, and none below; the hind femur of the male has an apical spine, but it is situated below, not laterally. It is absent in the female. Below there are, in both sexes, from two to four small spines. Both fore and middle tibiæ have a pair of inferior apical spines, but only one of the superior pair, which is on the inner side; below they have four spines in each row, and the middle tibia has a single spine in front, beyond the middle. The hind tibiæ, above, have four spines in the outer and five in the inner row; below there are three spines in the outer and two in the inner row. The fourth joint of the hind tarsus is short, not longer than the first. Supra-anal plate obtusely notched; the subgenital plate in the male deeply concave between the insertions of the styles; in the male it is large and slightly notched at the apex. The ovipositor is more compressed than usual.

Colours.—Dark; the pronotum bordered all round, and the abdominal terga bordered posteriorly, with testaceous or tawny. (In alcohol.)

Length, 25mm.; of head, 13mm. ♂, 10mm. ♀; of pronotum, 5mm.; of thorax, 9mm.; of abdomen, 15mm.; of oviduct, 13mm.; of fore tibia, 7mm.; of hind tibia, 12mm.; of hind femur, 11mm. Width of head, 7mm.; of pronotum, 8mm.

Localities.— Hooker Valley, South Canterbury; Mount Captain, Hanmer Plains, at about 3,000ft. above the sea. (Dendy.)

In the absence of apical spines on the femora, this species differs much from all the others.

The following are the colours of a live specimen collected by Professor Dendy on Mount Captain: Head shining-black, ante-clypeus white, with two brown spots. Antennæ reddish-brown, paler towards their tips. Legs pale reddish-brown, the spots on the outer surface of the hind femora and the spines on the hind tibiæ black. Pronotum shining-black, margined all round with dirty-white, clouded with fuscous. Abdominal segments, above, shining-black anteriorly; posteriorly white, with dead-black spots and vermiculations. The length of this specimen, which is a male, is 38mm.

Hemideina broughi.

Deinacrida broughi, Buller, Trans. N.Z. Inst., vol. xxviii., p. 324 (1896).

I have not seen this species, but it appears to be near *H. maori*, as the four anterior femora are said to be free from

spines. It is, however, much larger, and has different colours. The length is 57mm.; of ovipositor, 19mm.; of hind tibia, 38mm.; of hind femur, 38mm. The colours are pale reddish-brown, with the head and edges of the pronotum dark.

Locality.—Mountainous districts of Nelson. Living in holes which it bores in the trunks of trees.

Genus ONOSANDRUS, Ståll. (1878.)

Size moderate. Head small, the fastigium broad, flattened or rounded. Antennæ with the first joint thick, longer than broad; second joint shorter, not swollen; third joint about twice as long as the second; the rest small. Pronotum longer than broad, more than half the length of the thorax, narrowed anteriorly. Mesosternum and metasternum deeply bilobed. Legs medium; coxæ of fore and middle pairs spined; femora unarmed, those of the hind legs much dilated, continuously rounded above near the insertion, slightly sulcate below. Fore and mid tibiæ with two pairs of apical spines. Fore tibiæ without auditory pits. Hind tibiæ with three pairs of apical spines, of which the inferior are the shortest and the superior the longest; those on the inner side are as long as the first joint of the tarsus; those on the outer side are shorter; above the tibiæ are rounded with two rows of short spines terminated by a subapical pair as long as the superior apicals. Pads on the tarsi well developed; none of the joints spined; fourth joint shorter than the other three together. Supra-anal plate truncated. Cerci moderate. Subgenital plate of the male transverse, the apex between the insertion of the styles straight or slightly hollowed; the lobes carrying the styles not prominent. In the female the subgenital plate is triangular, the apex sharply pointed. The ovipositor is much compressed.

There is no sounding-file like that in *Hemideina*, but the ends of the terga of the first to the sixth abdominal segments are roughened, and these may serve as a sounding-organ.

Localities.—New Zealand, India, and Africa.

Ståll established this genus in 1878; it appears to be identical with *Libanasa*, of Walker, which was made in 1869.

KEY TO THE SPECIES.

a. Fore tibiæ, below, with 4 spines in each row.
  b. Mid tibia, above, with 2 or 3 spines on inner side .. *O. pallitarsis*
  bb. Mid tibia, above, with 4 spines on inner side.
    c. Mid tibia, above, with 2 spines on outer side .. *O. focalis.*
    cc. Mid tibia, above, with 3 spines on outer side .. *O. maori.*
aa. Fore tibiæ, below, with 3 spines in each row .. *O. maculifrons.*

Onosandrus pallitarsis. Plate XII., figs. 6, 6*a*.

Libanasa pallitarsis, Walker, Cat. Dermaptera Saltatoria in British Museum, part v., suppl., p. 24 (1871).

Head smooth, the front very faintly striated. Pronotum

margined, the lobes rounded, the lateral furrows obsolete. Hind femora transversely grooved on upper side only; those of the female with a short apical spine on the inner side. Fore and mid tibiæ, below, with four spines in a row; above the fore tibiæ have one anterior spine only, and the mid tibiæ have two anterior and two or three posterior spines. Hind tibiæ, above, with eight small spines in each row, in addition to the subapical spines; below there are three small distant spines. The subgenital plate of the male has the apex nearly straight between the insertions of the styles.

Colours.—Dark-brown or black, with a white spot on each side of the fastigium and a pale-tawny stripe down the centre of the head and back, especially well marked on the pronotum. A large patch of the same pale colour on the lobes of each of the thoracic nota, and some on the sides of the abdomen. Tarsi pale-yellowish. Some specimens are nearly all dark-brown.

Length, 23mm.; pronotum, 5 mm.; thorax, 8 mm.; abdomen, 14mm.; ovipositor, 11mm.; fore tibia, 4mm. ♂, 5mm. ♀; hind tibia, 9mm. ♂, 12mm. ♀; hind femur, 11mm. ♂, 14mm. ♀. Width of pronotum, 5mm.

Localities.—Wellington, Canterbury, Otago.

Common; generally in the earth among the roots of plants, sometimes in rotten wood. I have a specimen from the Hooker Valley.

Onosandrus focalis, sp. nov. Plate XII., figs. 5–5*d*.

Male: Head smooth, very slightly wrinkled in front; fastigium very broad and flat, the width more than three times that of the first joint of the antennæ. Thoracic nota margined, the lobes of the pronotum descending considerably below the others, uniformly rounded. Hind femora sulcate below, the transverse grooves on outer surface obsolete. Fore and mid tibiæ, below, with four spines in each row; above the fore tibia has two spines on the inner side; the middle tibia has two spines in the outer and four in the inner row. Hind tibiæ rounded above, with eight small spines in the inner and six in the outer row, besides the subapical spurs; below there are a pair of spines just behind the apical spurs, followed by four single spines. The first to the fifth abdominal terga have the anterior half of their lobes roughened, the posterior half smooth. Supra-anal plate triangular, broadly truncated at the apex. Cerci short, curved, erect. Subgenital plate distinctly concave at the apex between the insertions of the styles.

Colours.—Head black; a spot on each side of the fastigium, the lower part of the fastigium, the genæ, and the clypeus white. Clypeus with two black spots. Upper portion of clypeus and part of the face grey. Body black above, the front

margin of the pronotum and the posterior margins of all the thoracic nota and abdominal terga greyish-white; below greyish-white.

Length, 27mm.; pronotum, 7mm.; thorax, 11mm.; abdomen, 13mm.; fore tibia, 8mm.; hind tibia, 14mm.; hind femur, 17mm. Width of pronotum, 8mm.

Locality.—Ophir, in Central Otago.

Described from a single specimen only. The female is not known.

Onosandrus maori.

Onosandrus maori, Pictet et Saussure, Bull. de la Soc. Entomol. Suisse, vol. viii., p. 302, pl. i, fig. 4 (1891).

Fastigium rounded, the apex subangular; ocelli very distinct. Lobes of the pronotum much longer than high, ascending gradually posteriorly. Mid tibiæ, above, with 3–4 spines. Hind tibiæ keeled above with 10–12 short spines on each side; below they are rounded, with a small spine on each side beyond the middle.

Colours.—Dark-chestnut, spotted with testaceous.

Length.—11mm.; of pronotum, 5mm.; of hind femur, 11mm.

The males have the hind femora more dilated than the females.

Locality.—White-horse Hill, Hooker Valley (H. Suter).

I have not seen this species, and the above diagnosis is abridged from Pictet and Saussure's description.

Onosandrus maculifrons.

Libanasa (?) *maculifrons*, Walker, Cat. Derm. Salt. B.M., p. 209 (1869).

Fore tibiæ with three rather long spines on each side.

Colours.—Black; tawny beneath and on the sides of the abdomen. Head with a band of four testaceous spots on the front and one on each side of the face, which is also testaceous. Legs testaceous, slightly clouded with piceous.

Length, 16mm.

I have not seen this species, and the diagnosis is taken from Walker. There is a specimen from New Zealand in the British Museum, presented by Sir A. Smith.

Sub-family DOLICHOPODINÆ.

Body curved longitudinally, widest at the posterior margin of the mesonotum. Antennæ approximated at their bases. Clypeus not divided into ante-clypeus and post-clypeus. Pronotum as long as or longer than broad. Abdomen short, often shorter than the thorax, rather compressed; ovipositor sabre-shaped, much compressed, not tapering. Fore tibiæ without auditory pits. Hind tibiæ with from two to four pairs of

apical spines. Tarsi without pads on their lower surfaces; the first joint elongated, longer than the fourth. No ocelli in any of the New Zealand species.

SYNOPSIS OF THE GENERA.

Group CEUTHOPHILI.

Apical spines on the femora, when present, short, stout, and coloured. Spines on the upper surface of the hind tibiæ usually remote from each other, regular in size and in distance.

Genus *Talitropsis*.

Femora with a single short apical spine, or none. Fore tibiæ with a pair of inferior apical spines; middle tibiæ with a pair of inferior apical spines and a single superior spine, on the inner side; hind tibiæ with two pairs of rather short apical spurs, nearly equal in length

Genus *Ischyroplectron*.

Fore and middle femora each with a pair of strong apical spines; hind femora with one. Fore and middle tibiæ each with two pairs of apical spines; hind tibiæ with four pairs of apical spurs, of which the upper-intermediate are much longer than the others.

Genus *Gymnoplectron*.

Fore femora with one, middle and hind femora each with a pair of short apical spines. Fore and middle tibiæ with two pairs of apical spines; hind tibiæ with four pairs, of which the upper-intermediate are much longer than the others.

Genus *Pachyrhamma*.

Fore and middle femora each with a single apical spine, the hind femora with a pair. Fore and middle tibiæ with two pairs of apical spines; hind tibiæ with three pairs, of which the upper pair is much longer than the others.

Group RHAPHIDOPHORÆ.

Apical spines on the fore and middle femora, when present, acicular and colourless; none on the hind femora. Spines on the upper surface of the hind tibiæ irregular in size and distance, usually crowded.

Genus *Pleioplectron*.

Fore femora with one, or two, and middle femora with two, apical spines. Fore and middle tibiæ with two pairs of apical spines, of which the superior is much the longer.

Genus *Neonetus*.

Fore and middle femora each with a pair of apical spines. Fore tibiæ with a pair of inferior, and middle tibiæ with a pair of superior, apical spines; hind tibiæ with two pairs, of which the upper pair is much the longer.

Genus *Isoplectron*.

Fore femora without apical spines; middle femora with one only. Fore tibiæ with an inferior pair of apical spines; middle tibiæ with an inferior pair, and a single superior on the posterior side; hind tibiæ with two pairs, which are short and nearly equal in length.

Genus *Pharmacus*.

All the femora without apical spines. Fore and middle tibiæ with an inferior pair of apical spines, and a single superior on the posterior side; hind tibiæ with two pairs, moderate in size, the superior the longer.

Genus *Macropathus.*

All the femora without apical spines. Fore and middle tibiæ with an inferior pair of apical spines, and a single superior on the posterior side; hind tibiæ with three pairs of apical spines, of which the superior pair is much the longest, and the inferior pair the shortest.

Genus TALITROPSIS, Bolivar. (1882.)

Form small and robust. Vertex depressed; fastigium narrow, sulcated. Antennæ closely approximated at their bases, thick, evenly hairy, three or four times the length of the body; first joint much broader than the eyes, flattened; the second shorter, inflated; the rest cylindrical; the third rather longer than the second. Eyes pyriform, prominent in the male. Pronotum not more than half the length of the thorax, the inferior margins of the lobes straight. Metasternum with a low rounded elevation in the middle. Legs stout, covered with hair, except the hind femora, which are much dilated and polished; the hind tibiæ less than three times the length of the pronotum. Fore coxæ spined, the two approaching each other; hind coxæ as far apart as the middle ones. Femora without apical spines, or with a short stout one on the inner side. Fore tibiæ with a pair of inferior apical spines, and others below; middle tibiæ with a pair of inferior and a single superior apical spine, and others below; hind tibiæ with two pairs of apical spurs, both coloured and short, but the superior rather longer than the inferior pair; below they are without spines. First and second joints of the hind tarsi armed with a pair of strong spines at the apices; third joint very short; the fourth about equal to the other three together. Supra-anal plate with a semicircular notch at the apex. Cerci moderate, slender, depressed. Subgenital plate in the male rather transverse, inflated, trilobed, the styles very short. Subgenital plate in the female with three angular notches on the posterior margin. Ovipositor compressed, acuminate.

Locality.—New Zealand only.

The apical spines on the hind tibiæ have very few hairs.

Talitropsis sedilotti. Plate XII., figs. 7, 7*a*.

Talitropsis sedilotti, Bolivar, Ann. Soc. Ent. France (6), ii., p. 462 (1882). *Talitropis sedilloti*, Brunner, Mon. Stenop., p. 312, fig. 36 (1888).

Inferior margins of the pronotum slightly descending posteriorly; the posterior angles nearly rectangular. The lobes of the mesonotum and metanotum descend posteriorly more rapidly. Middle and hind femora with a small apical spine; fore femora without any; hind femora, below, with two or three small spines on the inner and one to three on the outer edge. Fore tibiæ, below, with two pairs of spines.

Middle tibiæ, below, with two spines on outer (anterior) and one on inner (posterior) side. Hind tibiæ, above, with eight large equal spines in the inner and seven in the outer row; inside each of these rows there is a row of small irregular spinelets between the larger spines; below they are unarmed. Second joint of the hind tarsi less than half the length of the first. Subgenital plate in the male trilobed between the insertions of the styles; the middle lobe rounded at the apex, keeled, and broader than the lateral lobes, which are acute.

Colours.—Variable: brown or tawny, variegated with darker; a pale longitudinal band on the pronotum; fore and middle tibiæ transversely banded.

Length, 16mm.; pronotum, 5mm.; thorax, 10mm.; abdomen, 6mm.; ovipositor, 14mm.; fore tibia, 7mm.; hind tibia, 12mm.; hind femur, 12mm. Width of mesonotum, 5mm.

Localities. — Pelorus Valley, Marlborough; Dunedin; Southland. The type, which is a female, is said to be ferruginous in colour, and the legs are slightly longer.

The Southland specimen, which is a female, is much more hairy than the others, the spines on the fore and mid tibiæ being almost buried. The hind femora, below, have two strong spines on each side, followed by four minute spines in the outer and two in the inner row. The colour is uniform dark-brown, with the legs banded. Perhaps it should be considered as a distinct species.

This species is remarkable for having four rows of spines on the upper surface of the hind tibiæ.

Talitropsis crassicruris, sp. nov. Plate XII., figs. 8, 8*a*.

Inferior margins of the lobes of the pronotum descending posteriorly, the posterior angles rectangular, with the corners rounded off. Lobes of mesonotum and metanotum with their inferior margins slightly rounded; all three in one line. Femora without any apical spines; hind femora, below, with two spines on the outer and one on the inner edge. Fore tibiæ, below, with two pairs of spines; middle tibiæ, below, with two on the anterior and one on the posterior side. Hind tibiæ much dilated and flattened above; the spines are nine on the outside and eight on the inside, equal in size, and at equal distances; no spines below. Second joint of the tarsi less than half the length of the first; first and second joints with a pair of strong apical spines. Subgenital plate of the male trilobed, the central lobe rather narrow, forming a strong keel. Cerci moderate; ovipositor rather short.

Colours.—Pale-tawny, variegated with brown on the upper surface; a pale longitudinal band on the pronotum; fore and middle tibiæ banded in the male.

Length, 23mm.; pronotum, 6mm.; thorax, 12mm. abdomen, 10mm.; ovipositor, 10mm.; fore tibia, 6mm.; hind tibia, 11mm.; hind femur, 12mm. Width at mesonotum, 6mm.

Locality.—Banks Peninsula and the Chatham Islands. Easily recognised by its thick hind tibiæ.

Talitropsis irregularis, sp. nov. Plate XII., fig. 9.

Not so hairy as the other species. Anterior margin of pronotum projecting over the occiput; inferior margins of the lobes horizontal. Fore and mid femora each with one rather long and weak colourless apical spine on the inner side; hind femora without apical spines, below with six minute spines on the outer and seven or eight on the inner edge. Fore tibiæ, below, with two pairs of spines; middle tibiæ, below, with two spines on posterior and one on the anterior side; hind tibiæ with the superior apical spurs longer than in other species of the genus; above there are thirteen spines in each row, equal in size and at regular distances. Second joint of the hind tarsus more than half the length of the first. Supra-anal plate short, concave at the apex. Supra-genital plate of male with the lateral lobes irregular and almost blended with the central lobe, which is broad and rounded at the apex, not keeled. Cerci rather long.

Colours.—Pale-tawny, variegated with brown; fore and middle tibiæ with dark bands.

Length, 12mm.; pronotum, 3mm.; thorax, 6mm.; abdomen, 6mm.; fore tibia, 6mm.; hind tibia, 9mm.; hind femur, 9mm. Width at mesonotum, 4mm.

Locality.—Auckland, under bark. (Suter.)

Described from a male; the female is unknown.

This species has apical spines on the fore and mid femora like those of *Pleioplectron*, and from this alone it would be included in the next group. But the apical spines of the fore and middle tibiæ, and the equal and equidistant spines on the upper side of the hind tibiæ, keep it in *Talitropsis*. The sub-genital plate of the male is also nearer that of *Talitropsis* than that of *Pleioplectron*.

Genus ISCHYROPLECTRON, gen. nov.

Size and form medium. Head perpendicular: antennæ short, slender, closely approximated but not touching at their bases; the first joint large, flattened, rather longer than broad; the second shorter, slightly inflated in the middle; the third much longer, slightly inflated at the base; the others much shorter, cylindrical. Fastigium high, narrow, deeply sulcated; eyes semicircular, not prominent. Pronotum not projecting much over the head. Metasternum with a blunt

tubercle in the middle. Legs rather long and slender, the hind femora but slightly dilated; coxæ of the fore legs spined, widely separated from each other, those of the hind legs closer together but separated by the first abdominal segment. Fore and middle femora with an apical pair of strong, movable, brown spines; those of the hind legs with a short apical spine on the inner side, as well as some small spines below. Tibiæ of fore and middle legs unarmed above, those of the hind legs unarmed below. Fore and middle tibiæ with two pairs of apical spines; the hind tibiæ with four pairs, of which the superior intermediate pair are very broad and strong, the inner and outer about equal; the pair below them not half the length of the superior pair; the other two pairs are quite small, and placed above and below the long spurs; the three lower pairs are articulated to the tibia, the upper pair are fixed; none of the spurs of the hind tibiæ have hairs. First and second joints of the hind tarsi with a pair of strong apical spines above; the fourth joint shorter than the first. Supra-anal plate roughened, concave at the apex. Cerci rather long, erect, curved, stout. Subgenital plate of the male transverse, rather inflated, the apex trilobed; styles short, the lobes bearing them rounded, not at all prominent.

Locality.—Bounty Islands only.

Ischyroplectron isolatum. Plate XII., figs. 10, 10*a*; Plate XIII., fig. 10*b*.

Ceuthophilus (?) *isolatus*, Hutton, Trans. N.Z. Inst., xxvii, p. 175 (1895).

Head smooth and shining; antennæ with short hairs. Lobes of the pronotum thickly margined, especially behind, their inferior margins nearly horizontal, slightly rounded; those of the mesonotum thickly margined, rounded, reaching rather below the lobes of the pronotum; metanotum not margined. Fore and middle femora unarmed below; hind femora, below, with six small spines on the inner and numerous small denticulations on the outer edge. Fore and middle tibiæ with three pairs of spines below; hind tibiæ, above, with eleven to thirteen distant spines, which are irregular in size; both surfaces rounded and slightly roughened. Subgenital plate of male with the middle lobe narrower and shorter than the lateral lobes, forming a rounded keel.

Colours.—Brown, the thorax and abdomen variegated with yellowish, the darker colour on the pronotum forming an indistinct St. Andrew's cross. Posterior margins of pronotum and mesonotum brown. Head pale; antennæ dark. Hind tibiæ and tarsi reddish-brown.

Length, 34mm. ♂, 29mm. ♀; pronotum, 9mm. ♂, 8mm. ♀; thorax, 16mm.; abdomen, 18mm.; ovipositor, 20mm.; fore

tibia, 18mm. ♂, 11mm. ♀; hind tibia, 30mm. ♂, 20mm. ♀; hind femur, 24mm. ♂. Width of mesonotum, 10mm.

Locality.—Bounty Island, under rocks. (Fairchild.)

Genus GYMNOPLECTRON, gen. nov.

Form large and slender. Head inclined under the body: antennæ slender, very long, approximated but not touching at their bases; the first joint large, longer than broad; the second shorter, rather inflated; the rest cylindrical; the hairs very short, none on the basal joints. Fastigium narrow, slightly sulcate. Fifth joint of the maxillary palpi considerably longer than the fourth, which is about equal to the third. Anterior border of the pronotum slightly rounded, projecting over the occiput; the posterior border straight; lateral lobes not projecting below those of the mesonotum. Sternum narrow. Legs long and slender; coxæ of the fore and hind legs nearly touching its opposite, the first segment of the abdomen entirely behind the hind coxæ; those of the fore legs spined. All the femora deeply grooved and spined below; fore femora with a small, blunt, coloured, apical spine on the inner side; middle and hind femora with a pair of blunt apical spines. Fore and middle tibiæ with two pairs of apical spines, unarmed above. Hind tibiæ with four pairs of apical spines, of which the superior intermediate are twice as long as those just below them, and the inner is longer than the outer; the superior and inferior pairs are small; all four pairs are articulated to the tibia, and all are without hairs; below they are rounded and unarmed, above they are flattened and armed with long spines. First and second joints of the hind tarsi terminating in a pair of rather strong spines; first joint longer than the fourth, but shorter than the other three together. Supra-anal plate very short, the posterior margin slightly concave. Cerci rather long and slender, erect. Subgenital plate of male linear, rounded at the apex and grooved below, projecting beyond the supra-anal plate; styles short and thick, inserted at each side of its base.

Locality.—New Zealand only.

Gymnoplectron longipes. Plate XII., figs. 11, 11*a*; Plate XIII., fig. 11*b*.

Hemideina longipes, Colenso, Trans. N.Z. Inst., vol. xix., p. 145 (1887). *Macropathus maximus*, Buller, Trans. N.Z. Inst., vol. xxvii., p. 145 (1895).

Head smooth; fastigium rather low, broadening out below the antennæ and gradually passing into the front. Pronotum margined, the inferior margins of the lobes horizontal, the corners only rounded. Lobes of the mesonotum and metanotum rounded, their anterior angles obliquely cut off. Inferior

keels of all the femora with numerous blunt serrations. Fore femora with four spines on the inner keel, none on the outer; middle femora with three spines on each keel; hind femora with about twenty-two spines on the outer keel and about twelve larger spines on the inner keel. Fore and middle tibiæ with three pairs of spines below. Hind tibiæ, above, with thirteen to eighteen long spines in the outer and twelve in the inner row, all nearly equal and at equal distances; longest of the apical spurs not more than half the length of the first joint of the tarsus; all the tibiæ finely granulated. Sides of the abdominal terga with scattered granules.

Colours.—Chestnut-brown, darkening on the abdomen, hind tibiæ, and tarsi. Fore and middle tibiæ and tarsi yellowish, the articulations chestnut-brown.

Length, 30mm.; pronotum, 10mm.; thorax, 18mm.; abdomen, 12mm.; fore tibia, 26mm.; hind tibia, 56mm.; hind femur, 49mm. Width of mesonotum, 11mm.

Localities.—Norsewood, on totara-trees; Coromandel, near Auckland.

Described from two male specimens, one of which is Mr. Colenso's type. The female is unknown.

Genus Pachyrhamma, Brunner. (1888.)

Body rather stout, legs slender. Head vertical. Antennæ thick, very long, touching at their bases, covered with long hairs; first joint much longer than broad; the second cylindrical, short; the third narrower but not much longer than the second, shorter than the first. Eyes large, semicircular. Fastigium rising abruptly, sulcate. Face flat, shining, glabrous. Maxillary palpi with the third and fourth joints subequal, the fifth rather longer. Pronotum roundly produced in front over the occiput, truncated behind. Sternum very narrow. Metasternum with an elevated transverse ridge. Legs long; fore coxæ touching each other; hind coxæ closely approximated but not quite touching; fore coxæ armed with a spine. Fore and middle femora each with a short, stout, apical spine on the inner side; hind femora with a pair of apical spines; all the femora sulcate below. Fore and middle tibiæ with two pairs of apical spines. Hind tibiæ with three pairs of apical spines, of which the superior pair is the longest, the inferior pair the shortest; above sulcate with numerous small equal and equally-distant spines; below rounded and finely granulated. The spurs on the hind tibiæ with long hairs. First and second joints of hind tarsi with a pair of small apical spines only. Supra-anal plate short, rounded. Cerci rather long. Subgenital plate lanceolate, produced. Ovipositor narrow, nearly straight. Subgenital plate of female small, the posterior margin broadly emarginate.

Locality.—New Zealand only.

There is considerable confusion among the species of this genus, if, indeed, there are more than one. I shall commence with the only species that has been adequately described, and then point out the characters which may possibly separate the others from it.

Pachyrhamma speluncæ. Plate XIII., figs. 12–12*c*.

Hemideina speluncæ, Colenso, Trans. N.Z. Inst., vol. XIV., p. 280 (1882).

Fastigium rather low. Antennæ long, nearly seven times the length of the body; basal joints cylindrical and nearly glabrous towards the middle, gradually getting swollen distally, and beyond the middle becoming cylindrical and hairy. In the middle each joint is swollen a little below the apex, and in many of the joints the lower side of this swelling bears a short, blunt spine; on the proximal half of the antenna these spines are small or rudimentary; near the middle, joints bearing small spines alternate with joints bearing much larger ones; there are no spines on the distal portion. Inferior margins of the lobes of the pronotum horizontal; the pronotum and mesonotum distinctly margined. Fore femora, below with a row of five spines on the anterior (inner) edge and none on the posterior edge. Middle femora, below, with two or three spines on each edge. Hind femora, below, with eight spines on the posterior (inner) and three on the anterior (outer) edge. Fore and middle tibiæ, below, with four spines in each row, and, in addition, the middle tibiæ have, above, four spines in an anterior and two in a posterior row. Hind tibiæ, above, with 36 spines in the inner and 41 in the outer row; these spines are distant in distal portion but smaller and more crowded in the proximal portion of the tibia. The superior pair of apical spurs are not half the length of the first joint of the tarsus, and the middle pair are not half the length of the superior pair; all of them have numerous long hairs. First joint of the hind tarsus not quite so long as the other three together; the third very short. In the fore and middle tarsi the first joint is longer than the other three together. Lobes of the abdominal terga with distant granulations. Subgenital plate of male with a lanceolate projection between the bases of the styles, which is strengthened by a Y-shaped keel; styles not projecting so far as the apex of the plate. Cerci slender.

Colours.—Pale-tawny; both borders of the pronotum and the posterior borders of the mesonotum, metanotum, and abdominal terga dark reddish-brown, the actual margins being white. Distal portions of the femora dark reddish-brown, with two white bands; tarsi nearly white.

Length, 25mm.; pronotum, 7mm.; thorax, 14mm.; abdomen, 14mm.; fore tibia, 21mm.; hind tibia, 38mm.; hind femur, 32mm. Width at the mesonotum, 9mm.

Locality.—Forty-mile Bush, near the head of the Manawatu River. In limestone caves (Colenso).

The foregoing description is taken from the type specimen, which is a male.

Pachyrhamma novæ-seelandiæ.

Pachyrhamma novæ-seelandiæ, Brunner, Verh. z.-b., Wien, xxxviii., p. 302, pl. vii., fig. 29 (1888).

This species, described from females only, is of the same colours and size as *P. speluncæ*, and the spines on the femora are the same, except that no mention is made of any on the middle femora in *P. novæ-seelandiæ*. It is, however, expressly stated in the generic characters that there are no spines on the upper surface of the fore and middle tibiæ, and no peculiarities in the antennæ are mentioned. From *P. fascifer* it differs only in having four or five spines on the lower surface of the fore femora instead of two, and in no mention being made of the two spines on the lower surface of the middle tibiæ.

Brunner's type is a female, and the figure shows the joints of the antennæ as cylindrical; probably it is the female of *P. speluncæ*.

Pachyrhamma fascifer.

Macropathus fascifer, Walker, Cat. Dermaptera Saltatoria in Brit. Mus., part i., p. 207 (1869); ♂. *Macropathus altus*, Walker, *l.c.*, p. 208 (1869); ♀.

This species has the same colours as *P. speluncæ*; but no mention is made of any peculiarities in the antennæ, nor of any spines on the upper surface of the fore tibiæ. The fore femora are said to have only two spines below, and the middle tibiæ three in each row, while *P. speluncæ* has five and four respectively. *M. fascifer* is said to have the fourth joint of the maxillary palpi much longer than the third, while in *M. altus* the two joints are said to be of equal length. There is no other difference.

Genus Plesioplectron, gen. nov.

Form small and slender. Head vertical. Antennæ thick, closely approximated at their bases; first joint very thick; the second much shorter, inflated; the third not much longer than the second; the rest small, vasiform or cylindrical. Fastigium narrow, rising abruptly, sulcate. Eyes subovoid, not very prominent. Pronotum rounded anteriorly and projecting over the head; posterior margin straight. Legs rather long. Fore coxæ spined, near together but not touching;

metasternum with a small tubercle or ridge; hind coxæ as far apart as the middle coxæ. Fore femora with one and middle femora with two apical spines, hind femora without apical spines. Fore and middle tibiæ with two pairs of apical spines; hind tibiæ with three pairs, of which the superior are acicular, hairy, more than half the length of the first joint of the tarsi, the middle pair about half the length of the superior pair, the inferior pair quite small; spines on the upper surface irregular in size, none beneath. First and second joints of hind tarsi with an apical pair of small spines; the first joint longer than the other three together, and with some minute spines on its upper surface. Supra-anal plate transverse, the apex truncated, with a small point in the middle. Cerci rather short, slender, depressed. Subgenital plate of the male longer than broad, cuspidate, terminating in an acute point between the styles; that of the female short, the apex with three points.

Locality.—New Zealand only.

KEY TO THE SPECIES.

a Joints of antennæ vasiform in the male.		
Fore and hind tibiæ with two or three spines in the inner row	*P. simplex*.	
Fore and hind tibiæ with one spine in the inner row	*P. hudsoni*.	
aa. Joints of the antennæ cylindrical		
Mid tibiæ unarmed above	*P. pectinatum*	
Mid tibiæ with three or four spines above ..	*P. diversum*.	

Pleioplectron simplex, sp. nov. Plate XIII., figs. 13–13*c*.

Antennæ about three and a half times the length of the body, closely covered with hairs; the joints in the male vasiform, each narrowing towards its base; the proximal joints rather broader than long. Thoracic nota very slightly bordered. Legs covered with short hairs, except the hind femora. Fore and middle femora unarmed below; hind femora with two minute spines near the distal end. Fore tibiæ, below, with three spines in each row, none above. Middle tibiæ, below, with two or three spines in each row, none above. Hind tibiæ flattened above, with about twenty-nine spines in the outer (anterior) and about seventeen in the inner (posterior) row, irregular in size, some very small. Subgenital plate in the male longer than broad, triangular between the insertions of the styles, slightly keeled near the apex. In the female the three apical points are nearly in the same line. Ovipositor rather slender.

Colours.—Fuscous, variegated with paler, a pale longitudinal line on the pronotum; antennæ fuscous; fore and middle femora and all the tibiæ transversely banded; the tarsi pale.

Length, 16mm.; pronotum, 4mm.; thorax, 8mm., abdomen, 10mm.; ovipositor, 11mm.; fore tibia, 7mm.;

hind tibia, 14mm.; hind femur, 13mm. Width at the mesonotum, 5mm.

Localities.—North Canterbury and Banks Peninsula. Among dead wood; not uncommon.

The female is considerably smaller than the male; the antennæ are relatively thinner, and the joints are cylindrical.

Pleioplectron hudsoni, sp. nov. Plate XIII., figs. 14, 14*a*.

Joints of the antennæ vasiform, sparingly clothed with hairs, the proximal ones broader than long. Thoracic nota slightly margined. Legs long, covered with short hairs. Fore and middle femora unarmed below; hind femora with two minute spines on the inner edge, nearly central. Fore tibiæ, below, with one anterior (inner) and two posterior (outer) spines, none above. Middle tibiæ, below, with two anterior (outer) and one posterior (inner) spines, none above. Hind tibiæ slightly grooved above, with about eight outer and twelve inner spines, and several minute teeth between them. Subgenital plate longer than broad, with the keel projecting forwards into a sharp narrow point.

Colours.—Reddish-brown, the legs transversely banded with paler.

Length, 12mm.; pronotum, 5mm.; thorax, 8mm.; abdomen, 3mm.; fore tibia, 9mm.; hind tibia, 16mm.; hind femur, 14mm. Width at mesonotum, 5mm.

Locality.—Wellington (Hudson).

Described from a single male; the female is unknown.

Pleioplectron pectinatum, sp. nov.

Joints of the antennæ cylindrical, sparingly covered with hairs, the proximal joints very short, much broader than long. Pronotum and mesonotum slightly margined. Fore and hind femora unarmed below; hind femora, below, with two minute spines on the inner edge near the distal end. Fore and middle tibiæ with two spines in each row below, none above. Hind tibiæ slightly grooved above, with about twenty-five spines in each row, irregular in size, some of them very small. Subgenital plate transverse, with a narrow keel ending in a point.

Colours.—Fuscous, the face and palpi pale; antennæ fuscous; a pale longitudinal line on the pronotum; femora and tibiæ of fore and middle legs pale, transversely banded with fuscous; tarsi of the fore legs pale-tawny, those of the middle and hind legs fuscous.

Length, 15mm.; pronotum, 5mm.; thorax, 7mm.; abdomen, 7mm.; fore tibia, 7mm.; hind tibia, 14 mm.; hind femur, 12mm. Width at mesonotum, 5mm.

Locality.—Banks Peninsula.

Described from two male specimens.

Pleioplectron diversum, sp. nov. Plate XIII., figs. 15–15*b*.

Joints of the antennæ cylindrical, closely covered with hairs, the proximal joints longer than broad. All the thoracic nota thickly margined. Legs hairy. All the femora unarmed below. Fore femora with a pair of short apical spines; those on the middle femora longer than usual. Fore tibiæ, below, with two anterior (inner) and three posterior (outer) spines; none above. Middle tibiæ, below, with three spines in each row; above, armed with a row of four spines. Hind tibiæ flattened above, with about twenty-five spines in each row, irregular in size, some of them very small. First joint of the hind tarsi considerably longer than the other three together; the third less than half the second. Subgenital plate of the female with three points, the middle one projecting much beyond the laterals.

Colours.—Dark-brown, variegated with paler; fore and middle femora and all the tibiæ transversely banded; tarsi of fore and middle legs tawny, those of the hind legs dark-brown.

Length, 17mm.; pronotum, 4mm.; thorax, 8mm.; abdomen, 8mm.; ovipositor, 12mm.; fore tibia, 7mm.; hind tibia, 15mm.; hind femur, 13mm. Width at the mesonotum, 5mm.

Locality.—Upper Wanganui (S. H. Drew).

Described from a single female individual.

The two spines on the fore femora of this species would place it in *Neonetus*, but the apical spines of the fore and middle tibiæ, and the subgenital plate of the female, show that it is nearer to *Pleioplectron*. The spines on the upper surface of the middle tibiæ are very unusual.

Genus NEONETUS, Brunner. (1888.)

Form small and stout. Head vertical. Fastigium rising abruptly, slightly sulcate. Antennæ long, rather slender, closely approximated at their bases in the female, rather distant in the male; the first joint very broad, flattened, the rest much shorter. Eyes large, semicircular, very prominent. Pronotum rounded anteriorly and projecting over the head; posterior margin straight. Legs moderate. Coxæ of fore legs spined. Fore and middle femora with a pair of acicular apical spines; hind femora without apical spines. Fore tibiæ with a pair of inferior apical spines; no superiors. Middle tibiæ with a pair of superior apical spines; no inferiors. Hind tibiæ with two pairs of apical spines, the superior much longer than the inferior. First and second joints of hind tarsi with a pair of small apical spines. Cerci short and robust. Subgenital plate in the male long, boat-shaped, strongly keeled, the styles inserted at the base of the plate. In the female it

is narrow, cuspidate, with a sharp point. Ovipositor large, much compressed.

Locality.—New Zealand only.

Neonetus variegatus. Plate XIII., figs. 16–16*c*.

Neonetus variegatus, Brunner, Verh. z.-b., Wien, xxxviii., p. 300, pl. vii., fig. 27 (1888).

Antennæ very hairy, the first joint longer than broad, the third shorter than the second. Thoracic nota margined at the sides. Legs moderately hairy. Fore and middle femora unarmed below; hind femora, below, with five or six small spines on the inner edge and eight or nine minute spinelets on the outer edge. Fore and middle tibiæ, below, with two spines in each row, unarmed above. Hind tibiæ grooved above, with twenty to twenty-two small spines in each row, rather irregular in size; the superior pair of apical spurs twice as long as the inferior pair, rather more than half the length of the first joint of the tarsus. First joint of the hind tarsi shorter than the other three together. Subgenital plate of the male rounded at the point, the styles slender, reaching rather beyond the end of the plate.

Colours.—Above brown, variegated with paler; below tawny. A dark lateral streak on the thorax and abdomen, passing above the margins of the thoracic lobes, which are pale; legs banded dark and light.

Length, 10mm.; pronotum, 3mm.; thorax. 6mm.; abdomen, 3mm.; ovipositor, 8mm.; fore tibia, 6mm.; hind tibia, 12mm.; hind femur, 10mm. Width at mesonotum, 4mm.

Locality.—Auckland, under the bark of trees; common.

Mr. Brunner's description, if it may so be called, is quite insufficient for recognition, so I have taken the commonest species to represent it.

Neonetus pilosus, sp. nov. Plate XIII., fig 17.

Antennæ very hairy; the third joint about as long as the second. Thoracic nota margined. Legs very hairy; fore and middle femora unarmed below; hind femora, below, with about eight minute spines on each edge. Fore and middle tibiæ, below, with one spine on the anterior and two on the posterior side. Hind tibiæ sulcate above, with about twenty-four spines in each row, rather irregular in size; apical spurs as in *N. variegatus*. Subgenital plate in the male more pointed than in *N. variegatus*, and the keel not extending beyond the bases of the styles.

Colours.—Above dark reddish-brown; lower portions of the lobes of the thoracic nota and the legs testaceous; the legs banded with brown.

Length, 11mm.; pronotum, 4mm.; thorax, 7mm.; abdomen, 5mm.; fore tibia, 6mm.; hind tibia, 11mm.; hind femur, 10mm. Width at the mesonotum, 4mm.

Locality.—Wellington, in old burrows of *Hepialus virescens* (Hudson).

Much more hairy than *N. variegatus*. Described from a single male specimen.

Genus ISOPLECTRON, gen. nov.

Form small, rather robust. Head vertical. Antennæ rather slender, not very hairy, about three times the length of the body, rather distant at their insertions; the first joint broader than long; the second nearly as long as the third; the others short, cylindrical. Fastigium low, slightly sulcate. Eyes large, pyriform. Pronotum projecting slightly over the occiput. Legs moderate, hairy, except the hind femora, which are glabrous and much swollen. Fore coxæ spined. Fore and hind femora without apical spines; middle femora with a small inner apical spine. Fore and middle tibiæ with an inferior pair of apical spines; those of the middle legs with a single superior apical spine also, on the posterior side. Hind tibiæ with two pairs of apical spurs, subequal in length, the largest considerably less than half the length of the first joint of the tarsus. First and second joints of the hind tarsi terminated above by two short spines; the first joint about equal to the other three together. Supra-anal plate transverse, truncated at the apex. Cerci stout. Subgenital plate in the male triangular, slightly keeled, the styles inserted on each side of the base. Subgenital plate in the female short, rounded, emarginate. Ovipositor large, deep, serrated near the point on both edges.

Isoplectron armatum, sp. nov. Plate XIII., figs. 18–18*b*.

Lobes of the pronotum horizontal, not margined. Legs very hairy. Fore and middle femora unarmed below; hind femora much dilated, armed below with two strong curved spines, and some smaller ones on the inner edge near the middle. Fore and middle tibiæ unarmed below and above. Hind tibiæ flattened above, with about fifteen spines in each row, irregular in size. Supra-anal plate with a circular fovea on each side, near the insertion of the cerci. Subgenital plate of the male with short styles which do not quite reach the apex of the plate.

Colours.—Pale-tawny, finely marbled with purplish-fuscous, and with two longitudinal lines of the same colour on the face; antennæ tawny.

Length, 12mm.; pronotum, 4mm.; thorax, 7mm.; abdo-

men, 7mm.; fore tibia, 6mm.; hind tibia, 12mm.; hind femur, 12mm. Width at the mesonotum, 4mm.

Locality.—Dunedin.

Isoplectron calcaratum, sp. nov. Plate XIII., figs. 19–19*b*.

Lobes of the pronotum horizontal, not margined. Legs very hairy. Fore and middle femora unarmed below; hind femora much dilated, armed below with a single long nearly straight spine on the inner edge beyond the middle. Fore tibiæ, below, with one pair of minute spines in the male, two pairs in the female. Middle tibiæ, below, without spines in the male, or with two small pairs in the female: all these spines are almost hidden by the hairs. Hind tibiæ flattened above, with ten or twelve spines and some small spinelets in each row. Subgenital plate in the male with the styles long, projecting beyond the apex of the plate.

Colours.—Pale-tawny, finely marked and dotted with brown.

Length, 13mm.; pronotum, 3mm.; thorax, 6mm.; abdomen, 6mm.; ovipositor, 7mm.; fore tibia, 4mm.; hind tibia, 8mm.; hind femur, 8mm. Width at mesonotum, 4mm.

Localities.—Wellington, in blossoms of *Metrosideros scandens* (Hudson). North Canterbury, among dead wood.

Genus Pharmacus, Pictet and Saussure. (1891.)

Form slender. Head vertical; antennæ thick, hairy, rather distant at their insertions. Fastigium narrow, deeply sulcate. Eyes ovoid, their internal margins straight. Pronotum rounded anteriorly, projecting over the occiput; the posterior margin straight, the posterior angles slightly rounded. Sternum rather broad. Legs long and slender, hairy, except the hind femora. Coxæ separated from each other, those of the fore legs spined. All the femora without apical spines. Fore and middle tibiæ with an inferior pair of apical spines, and a single superior one on the posterior side. Hind tibiæ unarmed below; the apical spurs are two pairs, the superior of which are not twice as long as the inferior and less than half the length of the first joint of the tarsus. First and second joints of the hind tarsi terminated above by two short spines. Supra-anal plate large and rounded, passing the cerci, which are moderate. Subgenital plate in the male longer than the pronotum, triangular, slightly keeled; the styles large, cylindrical, inserted before the middle of the plate.

Female unknown.

This description is taken from Messrs. Pictet and Saussure, but has been added to by some details kindly sent me by M. Pictet.

Pharmacus montanus.

Pharmacus montanus, Pictet et Saussure, Bull. de la Soc. Entomol. Suisse, tome viii., p. 304 (1891).

Legs very long; fore and middle femora unarmed below; hind femora but slightly dilated, armed below with one or two small spines on the inner edge. Fore and middle tibiæ, below, with three pairs of small spines; unarmed above. Hind tibiæ, above, with sixteen to eighteen spines in each row, the largest apical spur not passing the middle of the first joint of the tarsus.

Colours.—Black above, testaceous below.

Length of body, 11mm.; of pronotum, 3·5mm.; of hind femur, 10mm.

Locality.—Mount. Cook, at a height of 7,000ft. (G. E. Mannering.)

I have seen no specimen.

Genus MACROPATHUS, Walker. (1869.)

Form rather slender, with very long legs. Antennæ very long and thick, hairy; the first joint very large, as broad as long; the second short and swollen; the third cylindrical, longer than the first; the others short, cylindrical. Fastigium high, deeply sulcate. Eyes small, narrowly oval, not projecting so much as the genæ; situated, with the antennæ, in a depression; front very prominent below the antennæ. The three last joints of the maxillary palpi about equal. Pronotum rounded in front, projecting over the head. Sternum narrow. Fore coxæ not spined; the two approximated but not touching. None of the femora with apical spines. Fore and middle tibiæ each with a pair of inferior spines, and a single superior one on the posterior side. Hind tibiæ with three pairs of apical spines, of which the superior are the longest and the inferior the shortest, the superior about twice as long as the intermediate, but less than half the length of the first joint of the tarsus. First joint of the hind tarsi elongated, longer than the other three together, armed above with several minute spines in addition to the apical pair; the third joint well developed. Subgenital plate of the male triangular, the styles inserted at the base.

I have had to reconstruct this genus in order that it may be understood. It is very different from *Pachyrhamma*, but closely allied to *Pharmacus*.

Macropathus filifer. Plate XIII., figs. 20, 20*a*.

Macropathus filifer, Walker, Cat. Dermaptera Saltatoria in the Brit. Mus., part i., p. 206 (1869). (?)*Pachyrhamma edwardsii*, Brunner, Verh. k. k., Zool. and Bot., Gesellsch. in Wien, xxxviii., p. 302 (1888).

Antennæ very long, nine or ten times the length of the body. The vertex roughened; face hairy. Pronotum smooth, slightly margined in front and at the sides, inferior margins of the lobes horizontal, lateral grooves obsolete. Legs very hairy. Fore and middle femora unarmed below; hind femora, below, with six small spines on the inner and two on the outer edge near the middle; middle femora slightly grooved below. Fore and middle tibiæ, below, with three spines in the inner and four in the outer row; unarmed above. Hind tibiæ flattened above, about thirty spines in the outer and twenty-five in the inner row, irregular in size, some very minute; unarmed below. In addition to the apical pairs of spines, the first joint of the hind tarsi has several and the second joint one pair of minute spines on the upper surface.

Colours.—Brownish-red, the palpi and tarsi pale-yellow.

Length, 17mm.; pronotum, 5mm.; thorax, 9mm.; abdomen, 8mm.; fore tibia, 12mm.; hind tibia, 23mm.; hind femur, 21mm. Width at mesonotum, 5mm.

Locality.—Near Mount Arthur, Nelson, in limestone caves.

This description is from a male presented to the Museum by Mr. G. V. Hudson; I have not seen the female.

Mr. Brunner's specimens are larger and rather different in colour, being brownish-yellow spotted with chestnut, and the posterior margin of each segment pale. I think, from his very short description, that it is the same as *M. filifer*, but the length of the hind tibia, being 5·7 times the length of the pronotum, is more like *M. edwardsii.*

Macropathus edwardsii.

Hadenæcus edwardsii, Scudder, Pro. Boston Soc. of Nat. Hist., vol. xii., p. 408 (1869). (?)*Ceuthophilus lanceolatus*, Walker, Cat. Dermaptera Saltatoria in the British Museum, pt. i., p. 204 (1869).

Antennæ between five and six times as long as the body. Legs longer than in the last species. All the femora unarmed below.

Colours.—Dark-brown, with the palpi and tarsi pale.

Length, 22mm.(?); pronotum, 6mm.; thorax, 11·5mm.; fore tibia, 23mm.; hind tibia, 40mm.

Locality.—Collingwood, near Nelson, in limestone caves. (Edwards.)

I have not seen this species, but the absence of spines from the hind femur and its great length of leg seem to distinguish it from the last.

EXPLANATION OF PLATES XII., XIII

PLATE XII.

Fig. 1. *Deinacrida heteracantha*, supra-anal plate.
Fig. 1*a*. " subgenital plate of male.
Fig. 1*b*. " subgenital plate of female.
Fig. 1*c*. " sternum.
Fig. 2. *Deinacrida rugosa*, subgenital plate of female.
Fig. 3. *Hemideina megacephala*, supra-anal plate.
Fig. 3*a*. " subgenital plate of male.
Fig. 3*b*. " subgenital plate of female.
Fig. 3*c*. " sternum.
Fig. 4. *Hemideina femorata*, subgenital plate of male.
Fig. 4*a*. " subgenital plate of female.
Fig. 4*b*. " side view, showing sounding organ.
Fig. 5. *Onosandrus focalis*, supra-anal plate.
Fig. 5*a*. " subgenital plate of male.
Fig. 5*b*. " subgenital plate of female.
Fig. 5*c*. " hind tarsus
Fig. 5*d*. " side view, showing sounding-organ.
Fig. 6. *Onosandrus pallitarsis*, subgenital plate of male.
Fig. 6*a*. " subgenital plate of female.
Fig. 7. *Talitropsis sedilotti*, subgenital plate of male.
Fig. 7*a*. " subgenital plate of female.
Fig. 8. *Talitropsis crassicruris*, subgenital plate of male.
Fig. 8*a*. " apex of hind tibia.
Fig. 9. *Talitropsis irregularis*, subgenital plate of male.
Fig. 10. *Ischyroplectron isolatum*, subgenital plate of male.
Fig. 10*a*. " apex of fore femur.
Fig. 11. *Gymnoplectron longipes*, subgenital plate of male.
Fig. 11*a*. " apex of fore femur.

PLATE XIII.

Fig. 10*b*. *Ischyroplectron isolatum*, sternum.
Fig. 11*b*. *Gymnoplectron longipes*, sternum.
Fig. 12. *Pachyrhamma speluncæ*, supra-anal plate.
Fig. 12*a*. " subgenital plate of male.
Fig. 12*b*. " sternum.
Fig. 12*c*. " portion of antenna.
Fig. 13. *Pleioplectron simplex*, supra-anal plate.
Fig. 13*a*. " subgenital plate of male.
Fig. 13*b*. " subgenital plate of female.
Fig. 13*c*. " apex of fore femora.
Fig. 13*d*. " apex of hind tibia.
Fig. 13*e*. " portion of antenna.
Fig. 14. *Pleioplectron hudsoni*, subgenital plate of male.
Fig. 14*a*. " portion of antenna.
Fig. 15. *Pleioplectron diversum*, subgenital plate of male.
Fig. 15*a*. " portion of antenna.
Fig. 15*b*. " subgenital plate of female.
Fig. 16. *Neonetus variegatus*, subgenital plate of male.
Fig. 16*a*. " subgenital plate of female.
Fig. 16*b*. " apex of fore femur.
Fig. 16*c*. " apex of hind tibia.
Fig. 17. *Neonetus pilosus*, subgenital plate of male.

PLATE XIII.—*continued.*

Fig. 18. *Isoplectron armatum*, supra-anal plate.
Fig. 18a. " subgenital plate.
Fig. 18b. " hind femur.
Fig. 19. *Isoplectron calcaratum*, hind femur.
Fig. 19a. " apex of hind tibia.
Fig. 19b. " subgenital plate of female.
Fig. 20. *Macropathus filifer*, subgenital plate of male.
Fig. 20a. " portion of antenna.

ART. XV.—*Note on the* Mantis *found in New Zealand.*

By Captain F. W. HUTTON, F.R.S., Curator of the Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1896.*]

ONLY one species of *Mantis* is known to me in New Zealand, which is the following:—

Orthodera ministralis, Fabricius.

Orthodera prasina, Burmister, Handbook, ii., p. 526 (1839). *Mantis rubrocoxata*, Serville, Orthoptères, p. 203 (1839). *Bolidena hobsonii*, Blanchard, Voy. "Astrolabe" et "Zelée," Zool., iv., p. 356, pl. i., fig. 7 (1853). *Orthodera prasina*, H. de Saussure, Mel. Orthop. Mantides, p. 168 (1870). *Mantis novæ-zealandiæ*, Colenso, Trans. N.Z. Inst., vol. xiv., p. 277 (1882). *Mantis*, sp., Potts, Trans. N.Z. Inst., vol. xvi., p. 114 (1884). *Tenodera intermedia*, Hudson, Man. N.Z. Entomology, p. 109, pl. 17, fig. 2 (1892).

Inhabits Eastern Australia and Tasmania.

In this species the pronotum is rather broad, roof-shaped, and gradually getting broader towards the anterior end, which is truncated. It is also easily recognised by the black spot bordered with blue, on the inner side of each anterior femur.

The Rev. W. Colenso says that he first saw this insect at Napier in 1878. He had long been on the lookout for a New Zealand *Mantis*, as Dr. Sinclair had taken egg-cases to England nearly forty years before.* It does not appear to have reached Wellington in 1891, for Mr. G. V. Hudson thought that the species was confined to the South Island, his specimens having been obtained in Nelson. I never saw it in Auckland or the Waikato, where I lived from 1866 to 1870, but a specimen was sent me from Auckland about ten years ago.

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* See Dieffenbach's "New Zealand," vol. ii., p. 280.

I first made the acquaintance of this insect in the summer of 1873–74, at Clyde, in Central Otago, where it was looked upon as a new-comer. Mr. Potts observed it first in Canterbury in 1880. Since then it has become common, and is often brought to me to name, but always as an insect not seen before.

I think, therefore, that the species has been unintentionally introduced—into Auckland from Sydney, and into Otago from Tasmania or Victoria—at the time of the commencement of the gold-diggings, when large quantities of hay were brought to Otago from Australia. However, according to Mr. Wood Mason, New Zealand specimens have the reticulation of the tegmina less dense than those from Australia.

It is remarkable that this insect should have increased so much in numbers while the *Phasmas*, which used to be common, appear to have been exterminated in the neighbourhood of Christchurch by the introduced birds.

Tenodera intermedia was described in 1870 from a single female specimen in the Paris Museum, which was said to have come from Auckland; but no other specimen has been found in New Zealand, and it is hardly possible that so large an insect—more than 3in. long—should have escaped the keen eyes of Mr. Colenso and other collectors. I think, therefore, that we may suspect the correctness of the locality of the type specimen. This species may be easily distinguished from the last by the shape of the pronotum, which is narrow, the sides nearly parallel behind, slightly widening over the legs, and then narrowing towards the anterior end, which is rounded.

ART. XVI.—*On Two New Globe-fish.*

BY F. E. CLARKE.

[*Read before the Wellington Philosophical Society, 26th August, 1896.*]

Plates XIV., XV.

BEFORE proceeding with the descriptions of the two globe-fish, it may not be out of place to give a short epitome of the present varieties of the group Tetrodontina so far proved to inhabit the waters surrounding New Zealand, and to write shortly on the interesting facts evolved concerning the dermo-spinous development of the group generally, and its use in definition and analyses of genera and species and their analogies.

Of the family Gymnodontes, group Tetrodontina, we have now found indigenous *Tetrodon richei*, the two I hereafter describe (*T. gillbanksii* and *T. cheesemanni*), and *Dicotylichthys jaculiferus*.

T. richei is very numerous on the west coast of the South Island, the sweeping of a seine-net on the beach frequently drawing them up in hundreds, quite vitiating the air on such occasions with the nauseous and unpleasant odour appertaining to this species. As far as my inquiries extend, it appears to be of much less frequent occurrence from Cook Strait round the west coast of the North Island. I have often captured them on a light line when fishing for the so-called "herring" (*Agonostoma*) in the Hokitika River. The spines so freely and densely covering its body are always prominent and exposed, and may be described as short and bristly. Dr. Günther's catalogue description states the caudal peduncle is smooth, but as a more general rule I have found that the minute spines are present thereupon. I have had a long acquaintance with the Tasmanian variety, *T. hamiltonii*, having caught them in that colony in a small trawl-net, with the seine- and shrimp-net, and on the line. In the latter description of fishing they used to be a constant source of annoyance to those anglers who frequented the Tamar and neighbouring portions of the North and South Esk Rivers at Launceston in order to take the mullet (*Agonostoma* and *Mugil*) and the fish there designated "salmon-trout" (*Arripis*), but in this I understand their office has been usurped by the acclimatised *Tinca vulgaris*. I invariably found *T. hamiltonii* perfectly spineless, either externally or *in situ*, and that they had practically no capacity for distension of the body, nor had they any lateral fold. If actually the same fish, for such last reason it should be removed from the sub-genus *Gastrophysus*. This fish is very poisonous, and has caused loss of life when eaten, to my own knowledge.

It is undoubtedly unsafe to use any of the Tetrodons or Diodons for food, as they seem to be invariably poisonous, though their generally repulsive appearance protects them from such use in a great measure.

The variety of spines throughout the Tetrodontina run in gradations from plain striated or granulated scutes with scarcely any central prominence, and planted on the surface of the epidermis, to complicated or simple bulbous-rooted spines, either placed on the surface or wholly or partially imbedded in the dermis in grooves, pores, or fossæ, and of different lengths, shapes, and thickness, from that of a dagger-blade in miniature to the thinness of a hair, being either permanently rigid or capable of voluntary ejection or erection, and occurring in bands, patches, or all over the fish. In this

variation they form a valuable adjunct to other features appertaining to the group in adjusting a species in its systematic regularity.

Order PLECTOGNATHI.

Group TETRODONTINA.

Family GYMNODONTES.

Genus **Tetrodon.**

Sub-genus Crayracion.

T. gillbanksii, sp. nov.

I obtained my first view of this fish when fishing off the wreck of the "Hawea," at Moturoa, Taranaki, in January, 1895, an unknown blue-spotted fish several times following the bait to the surface without being hooked. On the 26th March of the same year a fine specimen was washed up alive on the beach at the same place, and was kindly sent me in a bucket of salt-water by Mr. Gillbanks, then foreman of works at the mole. This is the specimen now described, and reported by me in the *Taranaki Herald* a day or two afterwards. Since that time I have obtained another, but smaller, specimen in perfect condition (this I forward to the Wellington Museum), and have had a couple of "remains" brought me, one of which, consisting of the partially-decomposed skin only, must have been from a fish at least 14in. in length.

Strange to say, all that have passed through my hands have had a small punctured wound just before the root of the pectoral fin and on the edge of the gill-opening, perhaps the work of a small octopus.

The whole body, with the exception of the little "pads" (muscular) at the bases of the dorsal and anal fins, is uniformly covered with spines, which are much longer and stouter on the belly and lower portions of the sides. These spines are all retractile into fossæ, and are supplied with an oval bead-like or bulbous appendage adherent to their external sides and near the tips thereof. This bead-like appendage, when the spines are fully exposed, is capable of being stretched or drawn down, thereby fully uncovering the points, and, when the spines are retracted into the fossæ, forming a bead-like prominence at the mouths thereof. They are much larger and pure enamel-white on the lower sides and belly, but quite black on the upper sides, the tail, and the back, where they become smaller in regular order according to their distance from the abdomen. When fully exposed all the spines show a black skin surrounding their shafts. The spine *in situ* and exposed is delineated in enlarged drawing (Plate XIV.).

The mouth is rather smaller in proportion than such

feature in other genera. Eyes are of medium size, the distance *en profile* from the extreme tip of the snout to the anterior margin of the orbit being more than twice the diameter of the orbit. The nostrils are a single aperture on each side, two-lipped, the lips rising from the base with merely a suspicion of a tube. Height of the branchial orifice equals profile distance from centre of nostril to end of snout Distance from tip of snout to rearmost upper horn of branchial aperture is contained more than three times in total length to root of caudal. The vertical from anterior origin of dorsal falls in advance of origin of anal, whilst vertical from posterior termination of base of dorsal cuts median line of base of anal. Length of base of dorsal equals least depth of body at origin of caudal, and length of base of anal is an eighth less than that of dorsal. Inclusive of soft pad at foot, the height of dorsal exceeds that of anal by two-fifteenths. Basal termini of anal and dorsal are respectively distant from origin of caudal their own free heights. These two fins are fat and fleshy. Pectorals are broad and short, in extreme length equalling the basal length of anal. Extreme length of caudal equals distance between centre of orbit and superior extremity of "horn" of branchial orifice, or also distance between termini of bases of anal and caudal. Vertical of posterior margin of pectoral is a trifle less than the median line between tip of snout and origin of free portion of caudal. There was no fold whatever along lower side of fish.

Fin-ray formulæ: D., 15 (first very short); P., 14; A., 14; C., 9. Total length of fish, 8·5in. Total depth (immediately after death, before tissues were contracted by immersion in alcohol and glycerine, and when the inflation had subsided), 3·5in. Height of dorsal (free portion), 1·16in. Height of dorsal (inclusive of pad), 1·4in. Width at base of dorsal (free part), 0·7in. Height of anal (free part), 0·96in. Height of anal (inclusive of pad), 1·1in. Width of base of anal, 0·8in. Extreme length of caudal, 1·45in. Extreme spread of caudal, 2·7in. Extreme length of pectoral, 0·8in. Extreme spread of pectoral, 1·6in. Extreme diameter of orbit, 0·35in. Width of branchial aperture, 0·45in. Least depth of body at origin of caudal, 0·7in.

Top of head rather broad and flattened, as is the anterior part of back, getting more rounded towards origin of dorsal. The interorbital space almost equals the distance between superior margin of branchial orifice and posterior edge of orbit, and about equals height of free portion of dorsal. Belly very rounded, sides flattening a little towards tail, but keeping fairly plump, which last term decidedly indicates the whole appearance of the fish when alive and in a quiescent state.

When inflated, for which the capacity existed to a very considerable extent over the chin, cheeks, throat, abdomen, and sides, the spines were all forced into full prominence. It seemed to distend itself with both air and water, which were ejected with considerable force when the fish was in full vigour.

In life and for some little time after death the fish was a brilliant and striking object, in consequence of the vividness of its coloration, which was as follows: Ground-colour of top and front of head, back, and sides, and on to origin of caudal fin, a rich dark purple-brown, lightening in tint towards the lower surface, and thence changing into a brownish hue. The whole of the body covered with sharply-defined markings, small, circular, and more numerous on the front and top of head and fore part of back, gradually enlarging as they proceed down the sides of cheeks and body; towards the root of the tail again getting much smaller. Towards the lower sides and abdominal surface the shape of the spots changes gradually to oval, and they increase in size very much. These spots on the head, cheeks, back, and upper sides were of a light-blue colour, those towards the lower sides and on the abdominal surface more or less white. Over the abdomen the peculiar pure enamel-white bead-like processes were closely scattered and very prominent. The other portions of the surface had a more widely-scattered black punctured appearance, caused by the other beads on the spines before referred to, but which have hardly any prominence. Pectoral fins of an orange tint. Dorsal and anal red, more or less margined with yellow. Caudal red, lightening towards free margin. Lips light-red. Irides yellow. Tints soon became much duller after death, and when immersed in the preservative the rich dark purple-brown changed to black, whilst the blue-coloured spots faded.

The specimen I send for the Wellington Museum died with its spines partly protruded.

The second species of *Tetrodon* I have the pleasure of noting was also found washed up on the beach at Moturoa, on the 11th May, 1896, by Messrs. James, Reilly, and Pearn, fishermen, who kindly forwarded it to me. It may yet prove to be similar to one obtained about a year ago at Tauranga and sent to Mr. Cheeseman, of the Auckland Museum, but which was not, nor has it yet been, I believe, described. I saw this fish in its glass jar in the Museum referred to at the end of last year, but my casual view was not sufficient to make its identity a certainty. If it proves so it will be a confirmation of its permanent occurrence on our coasts—finding it in localities so far apart. I propose that the specific

name of *cheesemanii* be given it. This will identify it if future inquiry defines it to be the same, and, if not, it will be a further small tribute to so record the name of an earnest and assiduous worker in the cause of science.

Group TETRODONTINA.

Genus **Tetrodon.**

Sub-genus GASTROPHYSUS.

T. cheesemanii, sp. nov.

This fish is also of robust form, though it differs very much in its proportions from the last, the body being more elongated, though the head is more pronounced. The profile of front of face rises rapidly to opposite the nostrils, whence it obtusely runs back in an almost flat line to behind the vertical over rear of orbit, thence it gently curves to midway between this station and origin of dorsal, falling gently to such origin. Between the dorsal and origin of caudal profile view gives an idea of slenderness not borne out in fact, as that part, from a dorsal aspect, is seen to be widened considerably, there being quite a depression along the median line (but this is lost on contraction after immersion in spirit). The top of the head and interorbital space are almost flat and quite wide, and the anterior part of the back keeps like this, with but slight transverse convexity for some distance. The sides and cheeks are flattened. The lower part of each side of the body from the chin along under the cheeks and thence on towards the tail has a very strongly-marked ridge, angle, or keel, which forms a striking delimitation between the silvery lustre of the sides and the plain dead-white of the lower surface. The ridge or keeled projection much increases the lateral stoutness, and gives a very flattened appearance to the ventral aspect of the fish—in fact, it has what the nautical designer would term a "very hard bilge." From its running, though in a lessened altitude, round the chin it gives greater prominence than usual to such feature. This fish though capable of considerable distension of its skin, has not, such capacity to the same extent as the first-described *Tetrodon*, as in this instance it is confined to the skin of the throat and belly only. These parts are armed with fine short spines set in close and parallel rows in furrows running from the chin backwards. Between such furrows the whole of the skin of the localities named is divided into peculiar little flat-topped areas, oblong-rectangular and ovate in shape, and of enamel-white colour, running in regular rotation, the interspaces, of course, being more pronounced if the skin thereabout be distended. To the naked eye it resembles a

mass of minute mosaic-work; under the magnifying glass it has the appearance of the stomach-lining of some herbivorous animals.

This part, so spined and configured, is very distinctly divided from the rest of the lower surface, its margins being very abruptly and strongly defined. The remainder of the epidermis of the fish is perfectly free from spines, either exposed or hidden, except a patch covering the greater part of the interorbital space and fore part of the back, extending from thence towards the dorsal for a short distance in a triangular shape (the apex pointing rearward), and thence in a single row, ending near the dorsal with a slight widening in the pattern. These spines are small, weak, short, and exposed, very much smaller and finer than those on the belly, and with points inclined backward. The nose, cheeks, sides, back, and remainder of the under-surface are covered with skin smooth as satin, on the back and sides resembling that of the elephant-fish (*Callorhynchus*).

The anterior radices of the dorsal and anal fins commence in the same vertical plane, and posterior radices terminate in the same relationship. They are both furnished with and rise from a considerable muscular base, and are (with the caudal fin) of very fleshy nature. They are of even altitude, and agree in free altitude with the upper and lower free lobes of the caudal fin. The pectoral fins the birds had destroyed. The caudal fin is large and broad, margin much rounded The nostrils are formed by a low semi-spherical tubercle partially sunk in a sulcus, with two apertures in each, the anterior one rounded, the posterior one elongated. At the rear of each sulcus is a crescent-shaped little trench the posterior edge of which is crenulated. The nostrils are situated much closer to the orbit than to end of snout.

One eye was also destroyed by the birds; the remaining one had a silvery iris. The eye is comparatively large. The orbits are partially encircled by an extension of the lateral line, the lower limb of which extends along the cheeks well on under them towards and round the end of the snout, the upper limb running from the angle of divergence from the lateral line directly upwards, and then partly along top of head on each side, then down and between nostril and eye till it meets lower line. Another branch of the line diverges from that previously described, running down the sides of cheeks, and one crosses the back of the head. The lateral line itself runs in a wide angle from the first-described divergence high up the side, having another small branch as an offset from its lower side over origin of pectorals; from junction with this last small branch it curves still higher on to back, then follows along upper side for some distance, then

falls in a rapid slope to near the lower edge of sides, whence it again rises slightly and runs on to tail, being well marked for some distance along the caudal-fin membrane.

Fin-ray formulæ: D., 12; anal, 11; caudal, 10. Head is to body and tail as 4 is to 15. Head is to total length (to extreme margin of caudal) as 5 is to 21.

Colour of back and upper sides a rich plumbeous-green with silky reflections; sides of bright metallic silvery lustre; anal, dorsal, and caudal fins dull-yellow, darkening more or less to reddish-orange on some of the rays, margined with black, but terminating on their extreme borders with more or less opaque milk-white.

The mouth was rather larger and teeth stronger than those generally appertaining to the genus, that portion of the upper teeth nearest the division between same being distinctly thickened and rounded.

Total length of fish (extremity of snout to margin of caudal), 11·25in. Length of fish from extremity of snout to origin of caudal, 9·4in. Length from extremity of snout to gill-opening, 2·6in. Diameter of orbit, 0·6in. Length, extremity of snout to vertical from origin of dorsal fin, 6·9in. Greatest depth of body with stomach in normal condition, 3·5in. Median heights of free portions of dorsal, anal, and caudal fins, 1·3in.

The length of the head equals the vertical depth between the fin-ray origin of the dorsal and anal fins, and is much less than the full expanded width of the caudal fin. The shortness of the head as compared with the distance from same to dorsal, or with the head and body length or total length, is a considerable specific feature in distinguishing this from others so far described. The anal orifice is placed some distance in front of the origin of anal fin.

Decomposition proceeded very quickly with this fish after it was obtained, although it was perfectly fresh when brought to me, the skin being very tender. Perhaps this was hastened by the birds breaking into the fish through the gill-openings. Further decomposition was checked by immersion in strong alcohol, but this had the effect of considerably shrinking and distorting the specimen. It tightened up the peculiar mosaic-like development of the abdomen, causing the little spines to be almost completely hidden.

ART. XVII.—*Notes on the Occurrence of a Species of* Lophotes *on the Coast of Taranaki.*

By F. E. CLARKE.

[*Read before the Wellington Philosophical Society, 26th August, 1896.*]

Plate XVI.

THE fish came on shore in August, 1895, on the long flat beach south of the Waiwakaiho River mouth, Taranaki, and was brought into Mr. W. Bailey's butcher-shop, in New Plymouth, where it was on exhibit for a day. Unfortunately I had not the opportunity of seeing it personally, as I was ill at the time.

Rough sketches were made for me by Messrs. Saxton, Collis, Gordon, and Doile, who also contributed verbal descriptions of portions of the fish. Such information was further intelligently enlarged by Mr. J. Harvey, manager for Mr. Bailey in Central Devon Street shop, where the fish was exhibited as before mentioned. This he was able to do from his having the fish longer under his observation, and so verified several particulars not sufficiently defined by the previous descriptions and sketches.

The information received points to the stranger being a *Lophotes*, though in some features the descriptions clash with those given in Dr. Günther's catalogue; but, of all fish described (up to my present cognisance), the *Lophotidæ* have apparently escaped particular and minute attention in that respect from their excessively rare occurrence, and recorded specimens seem to be in bad condition as well. Our fish was described as being perfect, except that one side was slightly abraded from the rubbing on the sand, and one eye was partially destroyed by the gulls or sea-lice. The finder thought it must have run itself ashore whilst in pursuit of small fry—perhaps whitebait.

Where it differs from the catalogue description of the genus and family before mentioned it sometimes agrees with Swainson's remarks thereupon; in other respects critical differences arise which a lucky further knowledge may amend. Comparison of my notes with the authors quoted will define these.

It was stated by all to resemble in profile view the proportions and shape of the blade of a hand-saw, the head being high and abrupt; the dorsal line running back to the tail almost in a level, the ventral line rising in a gradual incline; sides very much compressed; in section the lower part of body being much thicker than the upper, it being described as running to a fine edge along the base of the dorsal fin. The dorsal fin was long and low; fin-rays very numerous, with some por-

tions projecting beyond the membrane. At the commencement of the dorsal on the top of the forehead was a stout curved spine or horn pointing forwards. Caudal fin small, but quite distinct. Ventrals were not noticed. Pectorals were not pointing upwards; they were described as being similar in shape to those of the Tamure. Anal fin placed very far back, in front of anal orifice; it was described as covering same when bent back. Gill-openings wide; eyes very large; mouth with short blunt teeth according to Mr. Saxton, without teeth according to the other describers, and was noted as being very small and tubular, "as if the fish lived by suction." In this Mr. Saxton's description differed from the others, he stating the mouth, though small, was *not* prominent, rather the reverse. This may be explained by its having been made to protrude after his seeing it. He was quite certain as to the existence of the blunt teeth; and, with regard to the dorsal spine, he estimates its height as much less than the others.

Skin very smooth and silky; scaleless. Colour purple-grey on back and upper sides, in places running down on to sides, making whitish patches. Rest of sides rose-coloured; belly golden. Flesh was described as very solid and white.

Length, about 4ft. 6in. to 4ft. 8in. Extreme depth at head, 1ft.; minimum depth at root of tail, about 1½in.; extreme thickness, about 1¾in.

I append an outline sketch (Plate XVI.) compiled from those supplied me; also one of *Lophotes siculus*, of Swainson, enlarged from one as figured by him, which was copied from a water-colour drawing prepared for the King of Sicily in 1815.[*]

Art. XVIII.—*Notes on certain Species of New Zealand Ducks.*

By W. W. Smith, F.E.S.

[Read before the Philosophical Institute of Canterbury, 1st July, 1896.]

Anas superciliosa, Gm. (Grey Duck.)

At the present time, when so much interest is evinced by ornithologists in the abnormal coloration of birds, it may be opportune to offer to this Institute some notes upon varied forms of the grey duck. Although the species is comparatively free from aberrations in plumage, several specimens exhibiting partial albinism and other forms of aberrant colour-

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* Since writing, I have seen vol. xxvi. of the Transactions, where I find, at p. 223, that a *Lophotes* was found in Otago (December, 1893). It seems to have been about the same length as the one now referred to.

ing have been collected and recorded by New Zealand ornithologists. The only papers on the subject that I am acquainted with are by Sir Walter Buller,* Mr. T. W. Kirk,† and myself.‡ Sir Walter has recently described§ several varieties, together with hybrids between the grey and the imported domestic duck. I have now to record several more varied forms which have for several years frequented the lakes in the public Domain at Ashburton. When the shooting-season opens in April large flocks of grey and other species of native ducks assemble on the lakes in the Domain and remain during the winter. As there is not sufficient food for them in the Domain, they repair in the evening to the river bed and adjacent swamps to feed during the night, and return in the early morning to spend the day unmolested under the willow-trees growing on the islands in the lakes. For several years I have observed their arrival in April, and have noted the occurrence of any individuals exhibiting colours diverging from the normal type. In July, 1892, a fine individual inhabited the lower lake, having its head, throat, and pectus pale-buff. The scapulars were beautifully mottled with white feathers, which made the bird conspicuous among the large flock of ducks resting on the lake. During the winter of 1894 a partial albino inhabited the Domain waters. The back, breast, and scapular region were of a faded white, while portions of the neck were lightly studded with pale-white feathers. The bird remained very timid throughout the winter, and never came to the banks of the lake with the others to feed on the oats or wheat we scattered there for them every morning. In the same year we observed a bird with the whole plumage tending to melanism. When swimming leisurely about on the lake, or when resting on the bank in the sunshine, the plumage appeared to be of a lustrous black. I have frequently watched the bird preening its feathers, and while thus engaged the under-parts appeared to be much paler than in normally-coloured birds. Last winter a fine individual with the primary wing-feathers pure white remained on the lakes from April until the 8th June, when they became frozen over and compelled many of the birds to seek food and shelter elsewhere. At the present time a remarkably-coloured form inhabits the lower lake—the head, breast, back, and tail pale-white; other parts normally coloured. The bird is extremely timid and watchful, and readily takes wing at the slightest disturbance. It is well known to ornithologists that albinoes and white varieties, and other conspicuously-aberrant forms, are more wary than

* Trans. N.Z. Inst., vol. vi.
† Trans. N.Z. Inst., vol. xiii., p. 235.
‡ The *Field*, June, 1891.
§ "Birds of New Zealand," 2nd edition, p. 251.

typically-coloured birds. They appear instinctively to know that their peculiar and striking colours render them more conspicuous to their enemies. Albinism unquestionably causes greater timidity and watchfulness in many species of birds so affected.

Being anxious to glean as many facts as possible on this interesting question, I have for some time made inquiries from several gentlemen who enjoy daily opportunities of observing flocks of ducks in a semi-wild state. From Mr. E. Herring, of Alford House, Springburn, I have received some valuable notes, which I avail myself of the privilege of giving *in extenso*. He says:—

"We protect the two hundred to three hundred grey ducks which visit our lake. I have not seen a true case of albinism, but several partial that are *not* crosses from the tame. Although I have seen several crosses at Mr. Grigg's, I have not observed one here.

"The ducks arrive here at break of day and leave as darkness comes on, flying generally in flocks of ten to twenty to their relative feeding-grounds east and west. During the day they rest on the banks of the lake, on stumps of trees just out of water, and occasionally on a fence, standing on the end of a stake on which a barbed wire is suspended. They take but little notice of ourselves until a different dress is worn. They apparently rest their evidence on colour. They will readily eat grain, and are fond of acorns, tramping across the lawn to the oak-trees. Except about a dozen which remain throughout the summer, the others do not come here from breeding-season to the commencement of the shooting-season.

"This year they arrived in large flocks on a Sunday, about a week before the shooting-season *legally* opened. That was not from instinct, but a measure of safety.

"The regular habitues of the place breed here on the islands, but never rear their young. Swans, tame ducks, and rats destroy them."

It is generally believed that the grey duck is untamable, and Sir Walter Buller states* that all attempts to tame them have failed. We have three dozen of these birds pinioned that were reared in the Domain during the last three seasons which are perfectly tame. They follow visitors along the walks for food, and while being fed several will lie on the walks and permit themselves to be stroked with the hand on the back. Like the paradise-duck, they are undoubtedly easily tamable.

In July the wild flock become more restless and spend more time on the water. The males chase each other, and

* l.c., p. 253.

fight and dive vigorously. By the middle of August they have generally all paired and disappeared to the swamps and river-banks of the plains to nest for the season. In the nesting-seasons of 1894–95 the pinioned grey ducks in the Domain reared fourteen broods, averaging six in a brood. The young are timid and wary for some time, but soon become quiet, and come skipping rapidly over the water when called to be fed.

The severe winter of last year proved disastrous to the native aquatic birds. As a proof of its severity, I may mention that many of the birds that came to the Domain waters were so weak from hunger as to be scarcely able to fly. We captured over two dozen, all in a benumbed, emaciated, and starving condition. After being well fed for several weeks they recovered, and, excepting a few which we pinioned, were again liberated. The severity of the winter also caused a much later and more prolonged breeding-season. I have one record of a brood of newly-hatched grey ducks on the 20th March, which is the latest date on which I have observed newly-hatched birds.

Dendrocygna eytoni, Gray. (Whistling Duck.)

Sir W. Buller, in the second edition of his "Birds," mentions only "two recorded instances of the recent occurrence of this species in New Zealand."* Three individuals—two males and one female—of this rare and beautiful duck have inhabited the lakes in the Ashburton Domain for three successive winters. During the earlier part of last winter, before the lakes became frozen, they fed freely with the grey and other ducks on oats and wheat scattered along the water's edge. We fed the whole flock regularly every morning after daybreak, all coming freely to feed after being hailed with a whistle. Owing to the mildness of the present winter, and the greater abundance of food obtainable everywhere, these birds are not so tame as they were last year. They are powerful fliers, while the peculiar shrill whistling sound they produce when flying distinguishes their flight from that of other ducks. These birds have hitherto left the Domain in August of each year, and returned the following April.

Rhyncaspis variegata, Finsch. (Shoveller, or Spoonbill Duck.)

Two pairs of this beautiful duck frequent the Domain lakes every winter, and consort amicably with the large flock of grey and other ducks inhabiting them. They are very tame, and are much attached to three domestic ducks which live on the lakes. For three seasons they have been among the

* *l.c.*, p. 269.

first to leave the Domain and the last to return. They are expert divers, and readily dive when molested by other ducks.

Fuligula novæ-zealandiæ, Steph. (New Zealand Scaup).

A few pairs of this sociable little duck inhabit the lakes here every winter. They associate with the mallards and domestic ducks, and when resting leisurely on the water's edge permit visitors to approach them very closely. They are gentle and slow in their habits, and at all times are beautiful objects when seen consorting peacefully with the other ducks inhabiting the lakes.

Art. XIX.—*On* Virgularia gracillima *in Lyttelton Harbour.*

By Arthur Dendy, D.Sc., F.L.S., Professor of Biology in the Canterbury College, University of New Zealand.

[*Read before the Philosophical Institute of Canterbury, 6th May, 1896.*]

On 22nd March, 1896, when dredging in the Lyttelton Harbour from the yacht of my colleague Professor Scott, we obtained about a dozen specimens of a small *Virgularia* from a shallow bottom of very soft tenacious mud. The species proved on examination to be Koelliker's *Virgularia gracillima*,* of which a single fragment only was obtained by the "Challenger" in Queen Charlotte Sound, and which has not since been recorded.

As this is an exceptionally interesting species, and so far very imperfectly known, it may be desirable to quote Koelliker's original description before adding my own supplementary notes. The description runs as follows:—

"*Virgularia gracillima*, n. sp. (pl. iii., fig. 11).

"A fragment of a *Virgularia* may be so named provisionally, as it seems to differ from all known species.

"Pinnules very small, about 0·85mm. high, and 1·1mm. distant from each other.

"Polyps four on each pinnule, without well-marked cells.

"Rhachis small, with a breadth of 0·48 to 0·51mm. in the middle part, and of 0·62 in the region of the undeveloped pinnules.

"Zooids—(?).

"Axis round, yellow, 0·42mm., large in the lowest part of

* "Challenger: *Pennatulida*," p. 10, pl. iii., fig. 11.

the rhachis, with the typical well-developed radiating fibres. Length of the whole fragment, 77·5mm.

"*Habitat.*—Station 167*a*, Queen Charlotte Sound, near Long Island, New Zealand. Depth, 10 fathoms. Mud. June 27, 1874."

All the specimens obtained from Lyttelton Harbour are smaller than the "Challenger" fragment, the largest, which, however, is imperfect above and below, measuring only 60mm. in length. Fortunately, however, one specimen is quite perfect, a condition very unusual in *Virgularia*. This specimen is 45mm. long. The length of the rhachis, or polyp-bearing upper portion, is about twice that of the stalk, or lower portion without polyps, although it is difficult to say exactly where the stalk ends and the rhachis begins, as the lowest polyps are merely minute buds. Both stalk and rachis are straight. The stalk is about 1mm. thick in the middle, and ends below in a thin-walled oval bulb. The greatest diameter of the rhachis, together with the pinnules, is 1·5mm.

Most of the pinnules contain four polyps, but the number varies somewhat, especially in some specimens. In the middle and upper parts of the rhachis the pinnules alternate with one another and overlap in pairs on the dorsal aspect. In the lowest part of the rhachis, where the polyps are first appearing as close-set transverse rows of minute buds, the young pinnules thus formed are opposite to one another. At the apex of the rachis the pinnules become smaller and the polyps fewer until they are finally represented by a few minute warts.

The slender calcareous axis is very sharply recurved at its lower end, and runs up again through the stalk for a little distance nearly parallel with its former course, thus forming an oblique loop, which is filled by a thin fibrous membrane stretched between the descending and ascending limbs. In a specimen dissected the lowest part of the loop was placed at a considerable distance from the end of the stalk, the bulbous dilatation lying below it.

There are no spicules.

The living colony is nearly colourless. Spirit specimens show a rather conspicuous longitudinal groove along the ventral surface of the rhachis.

ART. XX.—*Notes on New Zealand Land Planarians: Part III.**

By ARTHUR DENDY, D.Sc., F.L.S., Professor of Biology in the Canterbury College, University of New Zealand.

[*Read before the Philosophical Institute of Canterbury, 30th November, 1896.*]

THE following notes deal with a number of Land Planarians received from various parts of New Zealand during the past year. The majority were collected by myself on a trip to the west coast of the South Island in January, 1896, at Otira, Jackson's, Kumara, and Lake Mahinapua, near Hokitika. I am indebted to Sir James Hector for a large specimen of *G. triangulata* var. *australis*, from Nelson; to Mr. H. Suter for some very interesting specimens collected by himself at Dunedin; and to Mr. W. T. Locke Travers for valuable specimens from Wellington.

Geoplana sanguinea, Moseley.

Specimens of this widely-distributed species were met with in abundance under wood lying on the ground in paddocks between Lake Mahinapua and the sea-shore. I also found a single specimen at Kumara Junction. There is some difficulty in distinguishing between this species and *G. triangulata* var. *australis*, especially after preservation in spirit, when the dark purplish-brown colour of the latter has faded, and the pale supra-marginal bands are no longer distinct. I cannot help suspecting that, while *G. triangulata* var. *australis* is truly endemic, *G. sanguinea* may, after all, have been introduced from Australia. Its great abundance on cleared ground on the West Coast in company with introduced slugs (*Limax agrestis* and *Amalia gagates*) is very suggestive.

Geoplana triangulata var. australis, Dendy.

I have received from Sir James Hector a large specimen preserved in alcohol which is evidently referable to this variety. It was collected at Nelson, and is, I believe, the specimen referred to by Sir James Hector in the "Transactions of the New Zealand Institute," vol. xxv., p. 255. It is a singular fact that this unspeckled variety should occur both north and south of Christchurch, while in the Christchurch neighbourhood itself the speckled

* See Trans. N.Z. Inst., vol. xxvii., art. xvii., and vol. xxviii., art. xxii.

form, originally described as the type of the species, is extremely common and the other apparently entirely absent. The dark-brownish colour of the dorsal surface, with its narrow pale-coloured supra-marginal bands, is still very distinct in the Nelson specimen, even after a lapse of some years, and leaves no doubt in my mind as to the correctness of this identification.

Geoplana flavimarginata, n. sp.

Body very long and narrow, especially when crawling, when an average-sized specimen measures as much as 80mm. long by only 2mm. in breadth. In spirit the body is still long and narrow, flat below and convex above, about 40mm. long and 3mm. broad, with the peripharyngeal aperture 13mm. and the genital aperture 6mm. from the posterior extremity.

Dorsal surface in life very rich deep crimson or Indian red, with a narrow, sharply-defined, supra-marginal yellow band on each side, which contrasts strongly with the red. Anterior tip pink. Ventral surface yellow all over.

The eyes are numerous, but very minute and inconspicuous. The movements of the living worm are very active.

This species appears to be intermediate between *G. sanguinea* and *G. triangulata* var. *australis*. It is distinguished from the former by the very well defined yellow supra-marginal bands and by the narrower body, and from the latter by the much narrower body and the bright-red colour. From average specimens of both it is distinguished by its smaller size.

About a dozen specimens were sent to me alive by Mr. W. T. Locke Travers, of Wellington, who found them beneath a damp mat at the door of his greenhouse in May and June, 1896. As all the specimens agree closely with one another, I feel justified in distinguishing them by a new specific name. The locality suggests that the species may possibly be introduced.

Geoplana cucullata,* n. sp.

Body in life much flattened when at rest, but with no noticeable peculiarity in shape. In spirit, however, the shape is very characteristic: only about three times as long as broad, flattened on both surfaces, and with narrow crenate lateral margins; the anterior tip strongly curved ventralwards, beak-like, with smooth incurved margin forming a kind of hood, deeply excavated beneath and bearing the eyes along its edge; the posterior extremity generally broadly rounded, sometimes tapering rather abruptly.

* *Cucullata*, hooded.

The largest specimen measures, in spirit, 20mm. in length by 7mm. in breadth. Another specimen measures, in spirit, 15mm. by 5mm., while in life when crawling it measured about 34mm. by 3mm.

The peripharyngeal aperture, in spirit, is situated slightly in front of the junction of the middle and posterior thirds of the body, and the genital aperture is about half-way between it and the posterior end.

The eyes are very distinct, but arranged only in single series, or approximately so, around the anterior margin, and continued sparingly backwards along the lateral margins.

Dorsal surface in life brownish-yellow minutely speckled with warm brown, with paler narrow margins and a very narrow, ill-defined, pale median line. Ventral surface nearly white, faintly and minutely speckled with pale brown, except at the anterior end. Anterior tip very pale yellow or brownish yellow.

This remarkable species is certainly nearly related to *Geoplana latissima*, described in Part II. of these notes, from Springburn, but is distinguished by the narrower body, the more pronounced hood, and especially the colour markings; perhaps also by the absence of the median notch in the posterior margin.

I collected six specimens near Lake Mahinapua, under fallen logs.

Geoplana graffii var. occidentalis, nov.

Body at rest flattened above and below, tapering gradually in front, more suddenly behind. Dorsal surface with a narrow median stripe of dull orange or buff, very minutely speckled with brown, or even with a median very narrow brown line almost defined in the middle of the orange. The orange band is followed on each side by a broad band of dark-purplish tint thickly dusted with minute specks of bluish lustre, and first fading and then intensified on its outer edge to form a narrow band of nearly black colour, followed by the pale grey or buff margin of the body speckled minutely with darker grey or brown. Anterior tip brownish red. Ventral surface light brown, sometimes with an ill-defined lighter median band, and minutely speckled all over with darker brown. Size of average specimen about 53mm. by 4mm. when crawling, and 36mm. by 6mm. in spirit; genital aperture 11mm. and peripharyngeal aperture 16mm. from the posterior end in the same specimen in spirit.

This western variety is distinguished from the eastern types of the species by its larger average size, more speckled character, and more strongly developed dark band above the light marginal band. Though difficult to express in writing,

the difference is sufficiently striking and constant in actual specimens to merit the use of a distinctive varietal name.

I found four specimens of this variety at Otira, and six near Lake Mahinapua.

Geoplana graffi var. **otiraensis**, nov.

Body when at rest in life broad and much flattened, but convex above and somewhat triangular in section. When crawling, tapering very gradually in front, much less so behind. In spirit, flat or slightly concave below, more or less arched above, broader behind than in front, tapering very gradually to the narrow anterior extremity, more suddenly to the blunter posterior extremity.

A fair-sized specimen, in spirit, measures 33mm. in length by 6mm. in greatest breadth.

The peripharyngeal aperture, in spirit, is only very slightly behind the middle of the body, and the genital aperture only very slightly behind the junction of the middle and posterior thirds.

Dorsal surface in life dark-grey, intensified to black in the middle line, flecked all over with small whitish, greenish, or yellowish specks, varying in distinctness in different specimens. Anterior tip dark-grey. Ventral surface brown, minutely speckled with a darker tint, and with a paler-coloured narrow median band. Very narrow brown margins.

Two somewhat larger specimens, apparently of the same variety, have the pale median ventral and dark median dorsal bands either absent or very obscure, and one of them has an intensified supra-marginal band on each side of the dorsal surface.

Eyes numerous, and arranged as usual, but difficult to make out owing to the dark colour of the body.

This variety comes very near to *G. graffi* var. *somersii*, described in Part II. of these notes; but the present specimens are much larger, and differ slightly in pattern from those of the Springburn variety.

Five specimens were obtained at Otira, and one near Lake Mahinapua.

Geoplana moseleyi, Hutton.

I have received from Mr. Suter several specimens preserved in spirit which I have little doubt are referable to Hutton's species. They were collected at Dunedin, where Hutton's original type was also obtained. They agree very closely with Hutton's description, but the degree of development of the median dorsal stripe is variable, sometimes broad and sometimes very narrow, while the "interrupted narrow

black line" mentioned by Hutton as occurring near the margin of the stripe is also variable in its development.

I have long suspected that my *G. graffii* must be nearly related to *G. moseleyi*, but in the absence of more detailed information as to the latter I did not venture upon an identification. I now find that the species, assuming my present identification of Mr. Suter's specimens to be correct, are indeed very near together, the only tangible distinction lying in the paler-coloured ventral surface of *G. moseleyi*, and the absence from the ventral surface of any distinct speckling and of the distinct pale median band which characterize *G. graffii*. *G. graffii* also occurs at Dunedin, as I have previously recorded.

Perhaps in the future it may be desirable to unite the several varieties of *G. graffii* which I have described, together with *G. iris* and the Dunedin form described by Hutton, under the one name, *G. moseleyi*, which will then have to be regarded as a widely-spread species with numerous local varieties.

Geoplana inæqualistriata, Dendy.

I have found several more specimens of this species in my garden near Christchurch since writing the last part of these notes. I also obtained one planarian at Jackson's, on the Teremakau, which may possibly belong to the species, but it is not quite typical, and in some respects resembles *G. graffii*.

Geoplana jacksoniana, n. sp.

Body at rest in life much flattened, slightly convex above, very broad, tapering equally in front and behind. Movements very sluggish. Dorsal surface rich-brown marbled with short longitudinal dashes of grey and dull-orange, the orange dashes more abundant and paler in the middle line and above the margins. Ventral surface pale reddish-brown very minutely dusted with darker grey, except below the margins, where the brown is more intense; with indications of a pale narrow median line. Anterior tip grey.

In spirit the body is strongly convex dorsally and concave ventrally, 43mm. long by 6·5mm. broad; genital aperture 15mm. and peripharyngeal aperture 21mm. from the posterior end. Eyes as usual, with crowded lateral patches.

This species appears to be nearly related to *G. gelatinosa*, of which it may prove to be a variety, but the specimens look so different when placed side by side that I do not care to unite them under a common name. The difference lies chiefly in the thicker body and elongated colour-dashes of *G. jacksoniana*, which is also considerably larger, and has the external apertures more anteriorly placed. The sudden

tapering of the anterior extremity in *G. gelatinosa* also seems to be distinctive, even in spirit. In spirit, also, the colour of the two specimens is very different, but, as this may be due to different degrees of fading, I say nothing about it at present.

The single specimen was obtained at Jackson's, on the Teremakau, under a sawn log at the battery, some way up the mountain-side.

Geoplana splendens, Dendy.

This handsome species was originally described from a single specimen obtained at Jackson's by my sister, and it gave me great pleasure to meet with it again both at Jackson's and Otira. It may be at once recognised by the three bright-green stripes on the dark-brown background of the dorsal surface. I only found a single specimen at each of the above-mentioned localities.

Geoplana mariæ, Dendy.

I obtained one specimen of this species at Otira and four or five near Lake Mahinapua.

Geoplana subquadrangulata, Dendy.

I have now to record this common East Coast species from Otira, Jackson's, and Lake Mahinapua, on the West Coast, though it was not abundant at any of these localities. The Otira specimen was very dark-coloured, and had a faint green speckled lustre on the back, and only the narrow median dorsal stripe was recognisable.

I have also received varieties of this species collected at Dunedin by Mr. Suter.

Geoplana suteri, n. sp.

Body when crawling long and narrow; approximately oval in transverse section, flattened above and below; tapering gradually in front and behind. One specimen, when crawling, measured 44mm. in length by little over 2mm. in breadth, and the same, in spirit, 32mm. by 3mm.

In spirit the body is flattened above, more convex below, of approximately uniform width throughout, with the peripharyngeal aperture in about the middle, and the genital about half-way between it and the posterior extremity.

Eyes numerous, arranged as usual in antero-lateral patches, continued in approximately single series round the anterior tip.

In life the ground-colour of the dorsal surface was pale yellow-brown with six very narrow dark-brown stripes arranged in pairs, two being close together, one on each side of the middle line, and two not quite so close together, just

above each lateral margin and separated from the middle pair by an interval about twice as wide as that between themselves. The outermost stripe on each side may be less distinct than the others.

Ventral surface white, without markings. Anterior tip pinkish-brown.

I have named the species after Mr. H. Suter, who found it at Dunedin and gave me three specimens, one of which I received alive and two in spirit.

Art. XXI.—*The Lizards* (Lacertilia) *indigenous to New Zealand.*

By A. H. S. Lucas, M.A., B.Sc., and C. Frost, F.L.S.
Communicated by Captain F. W. Hutton.

[*Read before the Philosophical Institute of Canterbury, 1st July, 1896.*]

Our primary object in studying the lizards of New Zealand was to compare them with the lizards of Australia. We had made previously extensive collections of Victorian, and to some extent of Tasmanian and Straits, species, and had carefully examined other available collections. We wished to satisfy ourselves as to the identity or distinctness of these species and the New Zealand species, and to trace, where possible, their affinities.

Our conclusion is that the New Zealand forms are all endemic, and are all specifically quite distinct from the geckos and skinks of the Australian Continent. We have not had the opportunity of studying the lizards of New Caledonia at first hand, but from the descriptions it seems clear that they show much closer affinities with the New Zealand species than do the eastern Australian, but apparently no New Zealand form occurs in New Caledonia.

The publication of Dr. Boulenger's British Museum "Catalogue of Lizards" has established a more uniform and more satisfactory form of description of the species. Particulars of structure and of relative dimensions are of much greater importance than colour, and are accordingly allowed more weight in the descriptions.

We consider that all the specimens we have examined fall under the species enumerated in the British Museum catalogue, though there is doubtless more variation than Boulenger records amongst the skinks. We trust that the publication of this list, with Boulenger's descriptions and such

notes as we have been able to add from other sources of the habits and distribution of the New Zealand lizards, will be of use to future workers on the group.

We have to particularly thank Captain Hutton, of Christchurch, Professor Parker, of Dunedin, and Thomas Cheeseman, Esq., of Auckland, for forwarding collections of New Zealand lizards for examination.

LIST OF SPECIES

Geckonidæ.

Gymnodactylus arnouxii, A. Dum.
Naultinus elegans, Gray.
" *rudis*, Fischer
Hoplodactylus maculatus, Gray
" *pacificus*, Gray.
" *granulatus*, Gray.

Scincidæ.

Liolepisma grande, Gray.
" *moco*, D. and B.
" *lineo ocellatum*, A Dum.
" *smithii*, Gray.
" *æneum*, Girard.
Homolepida ornatum, Gray.

GECKONIDÆ.

Characters of the Family.

External Form.

Head and *body* more or less depressed, sometimes bordered by cutaneous expansions. *Tongue* fleshy, moderately elongate, very feebly incised anteriorly, capable of protrusion out of the mouth.

Tail presenting almost every possible shape, sometimes prehensile, almost always extremely fragile and rapidly reproduced. If reproduced it generally assumes an abnormal form and scaling.

Limbs, both pairs well developed, pentadactyle. The digits vary considerably, and furnish the characters upon which the systematic classification is based.

Eye and *Ear*.—The eye generally large, with vertical pupil, covered, as in snakes, by a transparent lid, under which it moves freely, the valvular lids being in most cases rudimentary. The tympanum usually more or less exposed.

Teguments.

Skin nearly always soft, with numerous tubercles or granules on the dorsal surface, and small, imbricated, cycloid or hexagonal scales on the ventral surface. Plate-like scales of the head only around the margin of the gape. The skin of the head usually free from the skull-bones.

Endo-skeleton.

Skull generally much depressed, with thin bones. Distinct nasals. Jugal rudimentary, the orbit not being bounded posteriorly by a long arch. No postfronto-squamosal arch. Pterygoids widely separated, without teeth. A columella cranii. Mandible of five bones, the angular and articular having coalesced.

Teeth pleurodont, small, numerous, closely set, with long slender cylindrical shaft and obtuse point. The new teeth hollow out the base of the old ones.

Vertebræ amphicœlous. Ribs long, and so prolonged as to form more or less ossified hoops across the whole abdominal region.

Limb-arches.—Clavicle dilated, perforated proximally. Interclavicle subrhomboidal to cruciform. Bones of the limbs, including those of the digits, well developed.

Mode of Reproduction.

Most geckos are oviparous, producing round eggs with a hard shell. The endemic New Zealand genera seem to be quite exceptionally viviparous.

GYMNODACTYLUS, Spix.

"Digits not dilated, clawed, cylindrical or slightly depressed at the base; the two or three distal phalanges compressed, forming an angle with the basal portion of the digits; the claw between two enlarged scales (a superior and an inferior), of which the inferior is more or less deeply notched under the claw; digits inferiorly with a row of more of less distinct transverse plates. Body variously scaled. Pupil vertical. Males with or without præanal or femoral pores."

The genus as defined ranges over Australia, the islands of the Pacific, tropical America, the borders of the Mediterranean, and southern Asia.

Gymnodactylus arnouxii, A. Dum.

Gymnodactylus arnouxii, A. Dum., Cat. Méth. Rept., p. 44, and Arch. Mus., vii., p. 479, pl. xviii., fig. 5; Boulenger, Cat., i., p. 39.

"In habit similar to *G. pelagicus*. Sixteen longitudinal very regular series of round, convex, smooth tubercles. Abdominal scales small, smooth. Tail with uniform small smooth scales, forming rings. Nostril pierced between the rostral, the first labial, and several nasals, the antero-superior of which is enlarged; eight upper and seven lower labials; mental very large, subtriangular, extending beyond the labials; a small chin-shield on each side of the mental.

Brown, lighter beneath; eight transverse dark bands between the occiput and the base of the tail.

"Head and body, 44mm.; tail, 41mm." *Boulenger.*

This species differs from *G. pelagicus* of Girard only in the rows of convex tubercles being smooth and the scales of the abdomen and tail not being keeled. This species was recorded as from New Zealand by A. Duméril; we have no other record of this lizard being found there. There are no specimens in the British Museum or in the museums of New Zealand. Perhaps best regarded as a variety of *G. pelagicus*, which has a wide distribution over the western Pacific, and as doubtfully occurring in New Zealand.

All the other New Zealand geckos belong to the small group consisting of the closely-allied genera *Naultinus* and *Hoplodactylus*. All the species are endemic.

Naultinus, Gray.

"Digits free, feebly dilated, gradually narrowing distally, clawed, with a series of transverse lamellæ under their entire length. Dorsal scales uniformly granular or intermixed with enlarged tubercles. Pupil vertical. Males with præanal and femoral pores."

The genus is confined to New Zealand.

Dr. Boulenger, in his "Catalogue of Lizards," has given us the results of his careful investigation of the New Zealand forms. He recognises two species of the genus *Naultinus*—*N. elegans*, Gray, and *N. rudis*, Fischer. A number of others have been described from time to time, but Dr. Boulenger includes all these as varieties of *N. elegans*.

The varieties as enumerated by Boulenger are distinguished entirely by differences in colour. We have found slight structural variations, but these have been in no way correlated with the variations in colour.

Naultinus elegans, Gray.

Naultinus elegans, Gray, Cat., p. 169. *Naultinus grayii*, Gray, Cat., p. 170. *Naultinus punctatus*, Gray, Cat., p. 170. *Naultinus elegans*, Gray, Zool. Misc., p. 72, and in Dieffenb. New Zealand, ii., p. 203; Steindachner, "Novara" Rept., p. 19; Buller, T.N.Z.I., iii., 1871, pl. ii., fig. 1; Hutton, T.N.Z.I., iv., 1872, p. 170; Boulenger, Cat., i., p. 168. *Naultinus punctatus*, Gray, in Dieffenb. New Zealand, ii., p. 204; Girard, U.S. Exploring Exped., Herp., p. 309, pl. xvi., figs. 17–26; Steindachner, "Novara" Rept., p. 20; Buller, *l.c.*, p. 8; Hutton, *l.c.*, p. 171. *Naultinus grayi*, Bell, Zool., "Beagle" Rept., p. 27, pl. xiv., fig. 2; Buller, *l.c.*, p. 7. *Gymnodactylus elegans*, A. Dum., Cat. Méth. Rept., p. 43, and Arch.

Mus., viii., p. 477, pl. xviii., fig. 14. (?) *Naultinus lineatus*, Gray, Ann. and Mag. N.H. (4), iii., 1869, p. 243. *Naultinus sulphureus*, Buller, *l.c.*, p. 8; Hutton, *l.c.*, p. 172. *Naultinus sylvestris* (Buller), Field, N.Z. Journal Science, i., 1882, p. 177. *Naultinus pulcherrimus*, Buller, T.N.Z.I., 1876, vol. ix., p. 326, pl. xvii. *Naultinus pentagonalis*, Colenso, T.N.Z.I., 1879, vol. xii., p. 251.

"Head small, short; snout obtusely subtriangular, short, measuring slightly more than the distance between the eye and the ear-opening, and twice the diameter of the orbit, with vertical loreal region and obtuse canthus rostralis; no trace of a concavity on the upper surface of the head; eye very small, with distinct circular lid; ear-opening very small, oval, horizontal. Body and limbs moderate, slightly depressed. Head covered with granular scales posteriorly, with polygonal, flat, or more or less convex, considerably larger scales on the snout; rostral about twice as broad as high, with distinct median cleft superiorly; nostril pierced between the first upper labial and three or four small nasals; eleven or twelve upper and ten or eleven lower labials; mental twice as broad as high anteriorly, narrowed posteriorly; the mental and labials followed by very small chin-shields gradually passing into the minute granules of the throat. Upper surfaces covered with small granules, lower surfaces with very small slightly-imbricated scales. Male with a large median patch of præanal pores and two series of femoral pores. Tail long, cylindrical, covered with very small subequal juxtaposed scales.

"Total length, 188mm.; head, 20mm.; width of head, 17·5mm.; body, 61mm.; fore-limb, 32mm.; hind-limb, 68mm.; tail, 107mm." *Boulenger.*

In order to show the great amount of colour-variation, it is convenient to enumerate the more definite colorations which occur, but it does not seem that these correspond to different varieties or races. Thus Sir Walter Buller writes,* "A live specimen which I kept for several months, and which presented only a few obsolete yellow marks on the back, gave birth to three young ones, each differently marked, but all having the double series of bright dorsal spots."

a. Type of *N. elegans*, Gray.—"Dark-olive above, yellow beneath, a streak on each side of the crown, another on the lower lip, and generally also one from axilla to groin, and large paired spots on the back and tail yellow black-margined." *Boulenger.*

According to both Hutton and Buller, purplish tints are due to spirit-discoloration.

* Trans. N.Z. Inst., iii., 1870.

b. N. punctatus, Gray.—"Green, upper portions minutely dotted with black; hands and feet yellow inferiorly." *Boulenger.*

c. N. grayi, Bell.—"Uniform green, lighter beneath; hands and feet yellow inferiorly." *Boulenger.*

d. N. sulphureus, Buller.—"Uniform bright sulphur-yellow, darker on the upper parts; abdomen bounded on each side by obsolete spots of paler yellow dotted with black on the margins; there is a similar obsolete mark three lines in extent on each side of the crown; soles of the feet pale-brown." *Buller, l. c.*, p. 8.

e. "Uniform lemon-coloured," lighter beneath.

f. "Uniform green above, yellow beneath."

g. "Green, lighter beneath, with a few distant paired yellow spots on the back, and a rather indistinct yellow streak from axilla to groin; hands and feet yellow" *Boulenger.*

h. N. pulcherrimus, Buller.—"Ground-colour vivid reddish-brown, with bright-green diamond-shaped spots arranged symmetrically on both sides; below, silvery-brown." (Found at Nelson.)

i. N. sylvestris, Buller.—"Blackish-brown above, variegated with pale-brown and sulphur-yellow; under-surfaces yellowish-white. (Viviparous; found in North Island.)

j. Dark sage-green above, with a lighter pattern; lower lip, chin-shields, and canthus yellow; a much-curved, broad, light band on each side of the occiput; two longitudinal series of unpaired lozenge-shaped spots on the back, continued on the tail; one or two series of large light spots between axilla and groin; all spots dotted and bordered with black; under-surfaces pale-green or yellowish, with or without darker dots.

k. "A stripe of golden-yellow down the centre of the back and a double series of transverse elliptical spots on a ground of delicate pea-green." *Buller.*

It would be interesting to know if the coloration is, as in *Chamæleon* and *Calotes*, at all under the control of the animal.

Habits.—Apparently almost as variable in habits as in colour. It is described as "defying detection amidst the evergreen foliage of *Leptospermum* and other shrubs" (*Buller*), as occurring frequently in the open fern land, and even as obtained under stones among the snow at a great elevation (*Hutton*). From the observations of Buller and Colenso * we learn that this species is viviparous, which is quite exceptional amongst geckos.

Distribution.—Over both North and South Islands.

* See two interesting papers by Colenso on the habits of individuals kept in captivity, Trans. N.Z. Inst., xii., p. 251, and xix., p. 147.

Naultinus rudis, Fischer.

Heteropholis rudis, Fischer, Abh. Naturw. Ver. Brem., vii., 1882, p. 236, pl. xvi. *Naultinus rudis*, Fischer, Boulenger Cat., i., p. 170.

"Head elongate, oviform, very distinct from neck; eye moderate, the eyelid not distinct inferiorly; ear-opening small, linear, oblique. Body and limbs moderate. Two lateral folds of the skin, enclosing a groove. Head covered with granular scales intermixed with larger flat scales, largest and most numerous on the snout. Rostral four times as broad as high; nostril pierced between the first upper labial and three nasals; ten upper and as many lower labials; mental three times as broad as high anteriorly, narrowing posteriorly; no chin-shields. Back covered with small granular scales intermixed, especially on the sides, with large, roundish, flat or keeled tubercles; lower-surfaces covered with imbricated scales; the throat granular. A large patch of præanal pores and a single series of femoral pores. Tail cylindrical, covered with irregular scales. Greenish-grey above, with irregular longitudinal and transverse purplish bands on the back; uniform light-grey beneath.

"Total length, 145mm.; from tip of snout to ear-opening, 17mm.; fore-limb, 20mm.; hind-limb, 26mm.; tail, 82mm." *Boulenger.*

We have not had an opportunity of seeing or examining this species; it would seem to be exceedingly rare. There is no specimen in the British Museum. Professor Hutton writes: "I have a single specimen, caught in the northern part of the South Island. It has no longitudinal bands. I have seen no other."

HOPLODACTYLUS, Fitzing.

Digits free or shortly webbed at the base, more or less dilated; the distal phalanges slender, elongate, clawed, forming an angle with the basal portion; a series of transverse lamellæ under the latter. Scales small, granular, equal. Pupil vertical. Males with præanal or præanal and femoral pores. Of the species grouped in this genus two belong to Bengal and to southern India respectively, and the rest are confined to New Zealand.

SYNOPSIS OF SPECIES.

I. Dilated portion of digit broad, its breadth equal to the length of the compressed distal phalanges, its length three times as great. Lamellæ all curved or chevron-shaped .. .. *H. maculatus.*

II. Dilated portion of digit narrow, its breadth much less than the length of the compressed distal phalanges, its length two-thirds that of the digit. Posterior lamellæ straight.

1. Digits about one third webbed. Ear-opening large, oblique, more than half the diameter of the orbit. Dorsal granules minute. No femoral pores. *H. pacificus.*
2. Digits slightly webbed. Ear opening round, less than half the diameter of the orbit. Femoral pores .. .. *H. granulatus.*

Hoplodactylus maculatus, Gray.

Naultinus pacificus, part (*N. maculatus*), Gray, Cat., p. 273.
Hoplodactylus maculatus, Gray, Boulenger Cat., i., p. 171, pl. xiv., fig. 1.

"Head short, oviform; snout as long as or slightly longer than the distance between the eye and the ear-opening, once and two-thirds the diameter of the orbit; ear-opening large, oval, oblique, two-thirds or three-fourths the diameter of the eye. Body and limbs moderate. Digits relatively much dilated; the length of the slender distal part equals the width of the dilated portion, which is contained about three times in the length of the same; the anterior inferior lamellæ chevron-shaped; ten to twelve lamellæ under the fourth toe; a very slight web at the base of the digits, absent between the two outer toes. Head covered with granular scales, minute on the posterior half, considerably larger on the snout. Rostral broad, subquadrangular or subpentagonal, with trace of median cleft above; nostril pierced between the first upper labial and four or five small nasals; eleven or twelve upper and nine or ten lower labials; mental small, triangular or trapezoid; small irregular chin-shields passing gradually into the minute granules of the throat. Dorsal scales minutely granular; abdominal scales very small, juxtaposed or subimbricate. Three or four angular series of præanal pores, the two upper extending sometimes on the thighs; the number of pores very variable. Tail cylindrical, tapering, covered with small equal subhexagonal scales arranged in verticils; the base of the tail strongly swollen in the males, the swollen part covered with large scales. Brown above, with small blackish spots and more or less distinct irregular transverse dark-brown bands on the back and tail; a more or less distinct dark streak on each side of the head, passing through the eye; lower surfaces dirty-white, sometimes with a few brown specks.

"Total length, 156mm.; head, 22mm.; width of head, 18mm.; body, 54mm.; fore-limb, 28mm.; hind-limb, 35mm.; tail, 80mm.

"*Var.*—A broad light band on each side of the back." *Boulenger.*

In some cases the length of the compressed distal part exceeds the width of the dilated portion. The rostral frequently just reaches the nostril. The labials are very variable, often not agreeing on the two sides of the same individual.

Distribution.—Common in the South Island; also on Stephens Island. *Hutton.*

Hoplodactylus pacificus, Gray.

Naultinus pacificus, Gray, Cat., p. 169. *Naultinus pacificus*, Gray, in Dieffenb. New Zealand, ii., p. 203; Buller, T.N.Z.I., iii., 1871, p. 7; Hutton, T.N.Z.I., iv., 1872, p. 172. *Platydactylus pacificus*, A. Dum., Cat. Méth. Rept., p. 35, and Archiv. Mus., viii., p. 455. *Hoplodactylus pomarii*, Girard, Proc. Ac. Philad., 1857, p. 197, and U.S. Exploring Exped., Herp., p. 294, pl. xviii., figs. 10–16. *Dactylocnemis pacificus* (Fitz.), Steindachner, "Novara" Rept., p. 11., pl. i., fig. 1. *Hoplodactylus pacificus*, Gray, Boulenger Cat., i., p. 173.

"Head oviform; snout distinctly longer than the distance between the eye and the ear-opening, once and two-thirds the diameter of the orbit; forehead slightly concave; ear-opening rather large, oval, oblique, half or three-fifths the diameter of the eye. Body and limbs rather slender. Digits not much dilated, the width of the dilated part being one-third the length of the same; the length of the slender distal part equals one-third the length of the digit, and is consequently much greater than the width of the dilated part; the anterior inferior lamellæ slightly angular; ten to twelve lamellæ under the fourth toe; a distinct web at the base of the digits absent between the two outer toes. Head covered with granular scales, minute on the posterior half, considerably larger on the snout. Rostral broad, subquadrangular or sub-pentagonal, with trace of median cleft above; nostril pierced between the rostral, the first upper labial, and four or five small nasals; eleven or twelve upper and nine or ten lower labials; mental small, trapezoid or triangular, generally followed by a small median chin-shield; small irregular chin-shields passing gradually into the minute granules of the throat. Dorsal scales minutely granular; abdominal scales very small, juxtaposed or subimbricate. Three or four short angular series of præanal pores, forming together a small sub-triangular patch; twenty to thirty-five pores altogether. Tail cylindrical, tapering, covered with small equal subquadrangular juxtaposed scales arranged in verticils; the base of the tail strongly swollen in the males, the swollen part covered with larger scales. Brown above, with irregular transverse bands on the back and tail, and frequently a dark band on each side, commencing from the tip of the snout and passing through the eye and above the ear; a short, dark, oblique streak directed posteriorly from the inferior border of the eye; lower surfaces whitish, immaculate.

"Total length, 163mm.; head, 20mm.; width of head,

15mm.; body, 57mm.; fore-limb, 28mm.; hind-limb, 37mm.; tail, 86mm." *Boulenger.*

The inner digits may be as much as one-third webbed; the labials very variable, often not agreeing on the two sides in the same individual.

Habits.—"Found generally under the bark of trees, but Mr. W. T. L. Travers informs me that at Lake Guyon, in the Province of Nelson, it is found under stones. It is exceedingly sluggish in its movements" (*Hutton*). "The marbled-brown skin is peculiarly adapted for concealment as it clings motionless to the bark of a tree or hides in the crevices" (*Buller*).

Distribution.—Professor Hutton writes, "This is found in the Auckland District. I have never seen it in the South Island. The Lake Guyon species is *H. maculatus.*"

Hoplodactylus granulatus, Gray.

Naultinus granulatus, Gray, Cat., p. 273. *Hoplodactylus granulatus*,* Gray, Boulenger Cat., i., p. 174, pl. xv., fig. 1.

"General characters and proportions as in *H. pacificus*—distinguished in the following important characters: Ear-opening smaller, not more than half the diameter of the eye. Digital dilatation very narrow; all the lamellæ straight; no trace of web. Scales of back and belly larger. Four to seven angular series of præanal pores, the three or four upper extending as femoral series; thirty to forty pores in the upper series, from one end to the other. Greyish or brown above, with dark-brown or reddish-brown vermiculations and irregular cross-bands light-edged in front; two dark streaks from the eye as in *H. pacificus*, separated by a yellowish interspace; lower surfaces whitish, generally with dark dots or variegations, especially on the gular region.

"Total length, 192mm.; head, 22mm.; width of head, 17mm.; body, 68mm.; fore-limb, 31mm.; hind-limb, 40mm.; tail, 102mm." *Boulenger.*

The two anterior lamellæ generally angular. Rudiment of a web between the inner toes, as figured by Boulenger (*l.c.*).

A very large specimen from Teanga Island, measuring 126mm. from snout to vent, showed a considerable amount of webbing, and relatively small dorsal scales, thus combining characters distinctive of *H. pacificus* and *H. granulatus.*

The three species of *Hoplodactylus* present similar variations in colour and markings.

Distribution.—Both Islands, also in Stephens Island. *Hutton.*

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* *Naultinus versicolor*, Colenso, Trans. N.Z. Inst., vol. xvii., p. 149, appears to be this species.—[F. W. H.]

SCINCIDÆ.

Characters of the Family.

External Form.

Head slightly depressed; *body* more or less round. *Tongue* moderately long, free and feebly nicked in front; covered with imbricate scale-like papillæ.

Tail usually long, cylindrical, covered with scales similar to those on the body, rather fragile, slowly reproduced.

Limbs very various, from well-developed and pentadactyle to quite rudimentary.

Eye and *Ear.*—Eye moderately large, pupil round, eyelids usually well developed, movable, except in *Ablepharus* (not a New Zealand form); scaly or with a transparent disk. Tympanum usually more or less exposed.

Teguments.

Skin covered with cycloid-hexagonal, rarely rhomboidal, imbricate scales, which may be either smooth or keeled, dorsals usually the largest, and laterals smallest. Head covered with symmetrical shields. No femoral pores.

Endo-skeleton.

Skull slightly depressed, præmaxillary bones two, sometimes incompletely separated; nasal double; frontal single or double; parietal single; postorbital and postfronto-temporal arches complete, osseous; interorbital septum and columella cranii well developed; infraorbital fossa present, bounded by the maxillary, the transverse bone, the palatine, and often also by the pterygoid. Skull with bony dermal-plates overroofing the supratemporal fossa.

Teeth.—Dentition pleurodont; the teeth conical, bicuspid, or with spheroidal or compressed crowns; the new teeth hollow out the base of the old ones. Pterygoid teeth may be present.

Vertebræ.—No ossified abdominal ribs.

Limb-arches. — Pectoral and pelvic arches constantly present. Clavicle dilated and perforated proximally; interclavicle cruciform.

Mode of Reproduction.

Oviparous or viviparous; eggs oval, shell membranous, flexible.

Lygosoma, Fitzing.

Palatine bones in contact mesially; pterygoid bones usually also in contact anteriorly, the palatal notch not extending forwards to between the centre of the eyes; pterygoid teeth minute or absent. Maxillary teeth conical or obtuse. Eyelids well developed. Ear distinct or hidden; if distinct,

tympanum more or less sunk. Nostril pierced in the nasal; supranasals present or absent. Limbs more or less developed, rudimentary, or absent.

There are over a hundred and fifty known species belonging to this genus, which extends over the whole of Australia, East Indies, China, North and Central America, tropical and South Africa.

Sub-genus LIOLEPISMA, Dum. and Bibr.

Limbs well developed; the length of the hind-limb exceeds the distance between the centre of the eye and the fore-limb. Lower eyelid with an undivided transparent disk. Tympanum distinct. No supranasals. Rostral forming a suture with the frontonasal. Frontal not broader than the supraocular region. One or more pairs of enlarged nuchals.

Liolepisma grande, Gray.

Mocoa grandis, Gray, Cat., p. 272. *Mocoa*(?) *laxa*, Hutton, T.N.Z.I., iv., 1872, p. 169. *Lygosoma (Mocoa) nigriplantare*, Peters, Mon Berl. Ac., 1873, p. 744. *Lygosoma (Liolepisma) grande*, Gray, Boulenger Cat., iii., p. 271, pl. xx., fig. 3.

"Habit lacertiform; the distance between the end of the snout and the fore-limb is contained once and one-fourth to once and two-thirds in the distance between axilla and groin. Snout moderate, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in a single nasal; no supranasal; frontonasal broader than long, in contact with the rostral and with the frontal; latter shield as long as frontoparietals and interparietal together, in contact with the two anterior supraoculars; four supraoculars; seven or eight supraciliaries; frontoparietals distinct, a little longer than the interparietal; parietals forming a suture behind the interparietal; a pair of nuchals and a pair of temporals border the parietals; sixth upper labial below the centre of the eye. Ear-opening oval, a little smaller than the eye-opening, with a few projecting granules anteriorly. Forty to fifty smooth scales round the middle of the body: laterals smallest. Præanals scarcely enlarged. The hind-limb reaches the wrist in the adult, nearly to the axilla in the young. Digits moderately elongate, subcylindrical; subdigital lamellæ smooth, twenty-eight or twenty-nine under the fourth toe. Tail about once and a half the length of head and body. Black above, spotted all over with pale-olive or olive dotted with black; lower surfaces greenish or pale-olive.

"Total length (tail reproduced), 215mm.; head, 20mm.; width of head, 14mm.; body, 84mm.; fore-limb, 30mm.; hind-limb, 42mm." *Boulenger.*

Four supraoculars followed by a small fifth, and usually eight supraciliaries; sixth upper labial sometimes below the eye, but more usually the seventh or eighth, not always the same on the two sides in the same individual. Boulenger, in above description, gives from forty to fifty scales round the middle of the body. In all the specimens which we have examined the number exceeds fifty, ranging from fifty-four to sixty-six. The lamellæ under the fourth toe, twenty-five to twenty-nine. The disk usually not much larger than the nostril. The under-surfaces of fingers and toes black.

We have one specimen in which the frontonasal is divided transversely, giving the appearance of an extra semioval shield between the frontonasal and frontal. This would seem to be an example similar to the one on which Hutton founded his *Mocoa laxa* (*l.c.*). In another individual the frontal is similarly divided longitudinally into two unequal shields.

Distribution.—South Island, among rocks. *Hutton.*

Liolepisma moco, Dum. and Bibr.

Hinulia ornata, part, Gray, Cat., p. 77. *Mocoa zelandica*, Gray, *l c.*, p. 82. *Mocoa owenii*, Gray, *l.c.*, p. 272. *Lygosoma moco*, Dum. and Bibr. v., p. 718. *Tiliqua zelandica*, Gray, in Dieffenb. New Zealand, ii., p. 202. *Mocoa zelandica*, Gray, Zool. "Erebus" and "Terror," Rept., p. 8, pl. vii., fig. 4; Hutton, T.N.Z.I., iv., 1872, p. 168. *Hinulia ornata*, Gray, *l.c.*, pl. xi., fig. 1. *Oligosoma zelandicum*, Girard, U.S. Exploring Exped., Herp., p. 246, pl. xxvii., figs. 9–16. *Euprepes moco*, Steindachner, "Novara," Rept., p. 47. *Hinulia variegata*, Buller, T.N.Z.I., iii., 1871, p. 5, pl. ii., fig. 3. *Mocoa striata*, Buller, *l.c.*, p. 6, pl. ii., fig. 2. *Mocoa zelandica*, part, Günther, Zool. "Erebus" and "Terror," Rept., p. 13. *Lygosoma (Liolepisma) moco*, D. and B., Boulenger, Cat., iii., p. 272.

"Habit lacertiform; the distance between the end of the snout and the fore-limb is contained once and a half to once and three-fourths in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the centre of the nasal; no supranasal; rostral nearly twice as broad as deep; frontonasal broader than long, forming a suture with the rostral and with the frontal; latter shield a little shorter than the frontoparietals and interparietal together, in contact with the two anterior supraoculars; four supraoculars, second largest; six or seven supraciliaries; frontoparietals distinct, a little longer than the interparietal; parietals in contact behind the interparietal, bordered by a pair of nuchals and a pair of temporals; two to five pairs of nuchals; usually fifth upper labial below the

centre of the eye. Ear-opening roundish or oval, much larger than the transparent palpebral disk; usually with one or two projecting granules or small lobules; twenty-eight to thirty-two smooth scales round the middle of the body; dorsals largest. Præanal scales not or scarcely enlarged. The adpressed limbs meet or fail to meet. Digits moderately long, subcylindrical; subdigital lamellæ smooth, twenty to twenty-eight under the fourth toe. Tail once and one-fourth to once and two-thirds as long as head and body. Brown or olive above, with a more or less regular, black-edged, light dorsolateral streak; back uniform, or spotted with blackish and yellowish, or with three dark-brown, black-edged, longitudinal lines; usually a yellowish black-edged streak on the upper lip to the ear, another from the ear to the groin, a third on the anterior face of the fore-limb, and a fourth on the hinder side of the hind-limb; lower surfaces yellowish, greyish, or pale-olive, uniform or black-spotted.

"Total length, 176mm.; head, 13mm.; width of head, 9mm.; body, 61mm.; fore-limb, 18mm.; hind-limb, 26mm; tail, 102mm." *Boulenger.*

Habits.—Found under stones and logs, both in the bush and open country. *Hutton.*

Distribution.—Common throughout the Islands. *Hutton.*

Liolepisma lineo-ocellatum, A. Dum.

Lygosoma lineo-ocellata, A. Dum., Cat. Méth. Rept., p. 169, Peters, Mon. Berl. Ac., 1873, p. 745. *Mocoa zealandica*, part, Günth., Zool. "Ereb." and "Terr.," Rept, p. 13. *Lygosoma (Liolepisma) lineo-ocellatum*, A. Dum., Boulenger Cat., p. 273.

"Very closely allied to *L. moco*; larger, stouter. Rostral slightly broader than deep, more produced superiorly. Thirty-two to thirty-six scales round the body. Coloration very similar to that of *Chalcides ocellatus*. Back pale-brown or greyish-olive, with small black spots or ocelli with white centre; a more or less marked whitish dorso-lateral band, beginning on the nape; sides variegated with blackish or blackish dotted with white; lower surfaces greyish, throat and breast black-spotted.

"Total length, 205mm.; head, 17mm.; width of head, 13mm.; body, 73mm.; fore-limb, 25mm.; hind-limb, 32mm.; tail, 115mm." Boulenger.

Distribution.—South Island; also Stephens Island. *Hutton.*

Liolepisma smithii, Gray.

Mocoa smithii, Gray, Cat., p. 82. *Lygosomella æstuosa*, Girard, U.S. Explor. Exped., Herp., p. 251, pl. xxvii., figs. 1–8. *Euprepes smithii*, Steindachner, "Novara"

Rept., p. 47. *Mocoa zealandica* (part), Günth., Zool. "Ereb." and "Terr." Rept., p. 13. *Norbea isolata*, Hutton, T.N.Z.I., iv., 1872, p. 170. *Lygosoma (Liolepisma) smithii*, Gray, Boulenger Cat., iii., p. 274.

"Habit lacertiform; the distance between the end of the snout and the fore-limb is contained once and one-third to once and three-fourths in the distance between the axilla and groin. Snout moderate, obtusely pointed. Lower eyelid with an undivided transparent disk. Nostril pierced in a nasal, which is often divided by an oblique suture; no supranasal, frontonasal usually not much broader than long, forming a suture with the rostral and with the frontal; latter shield as long as or longer than frontoparietals and interparietal together, in contact with the two anterior supraoculars; four supraoculars, second largest; six or seven supraciliaries; frontoparietals distinct, usually a little longer than the interparietal; parietals in contact behind the interparietal, bordered by a pair of nuchals and a pair of temporals; usually two or three pairs of nuchals behind the anterior pair; fifth and sixth upper labials below the eye. Ear-opening oval, about as large as the transparent palpebral disk, without or with a few very minute projecting lobules anteriorly. Thirty-six or thirty-eight scales round the middle of the body; dorsals largest, and frequently striated or feebly pluricarinate. Præanal scales not or scarcely enlarged. The adpressed limbs may overlap or fail to meet. Digits moderately long, subcylindrical; subdigital lamellæ smooth, sixteen or twenty under the fourth toe. Tail about as long as head and body. Brown or olive-brown above, usually with small black spots and a more or less distinct light dorso-lateral band, which is edged inferiorly by the dark-brown of the upper part of the sides; flanks paler, often with light dots; lower surfaces yellowish or pale-olive, throat usually variegated with blackish. Some specimens almost entirely black.

"Total length, 116mm.; head, 13mm.; width of head, 9mm.; body, 43mm.; fore-limb, 15mm.; hind-limb, 22mm.; tail, 60mm." *Boulenger.*

Distribution.—Both Islands, and Chatham Islands. *Hutton.*

Liolepisma æneum, Girard.

Cyclodina ænea, Girard, U.S. Explor. Exped., Herp., p. 236, pl. xxvi., figs. 9–16. *Lygosoma (Liolepisma) æneum*, Girard, Boulenger Cat., iii., p. 275. *Liolepisma micans*, F. Werner, Abh. k. k. zool.-bot. Ges. in Wien, xlv., p. 15.

"The distance between the end of the snout and the fore-limb is contained once and two-thirds to twice in the distance between axilla and groin. Snout very short, obtuse. Lower

eyelid with an undivided transparent disk. Nostril pierced in the centre of the nasal; no supranasal; frontonasal broader than long, forming a suture with the rostral and with the frontal; præfrontals small; frontal a little shorter than fronto-parietals and interparietal together, in contact with the two anterior supraoculars; four supraoculars; seven supraciliaries; frontoparietals distinct, as long as or a little longer than the interparietal; parietals in contact behind the interparietal; a pair of nuchals and a pair of temporals border the parietals. Ear-opening roundish, hardly as large as the transparent palpebral disk. Twenty-six or twenty-eight scales round the body; dorsals largest and more or less distinctly striated. Præanal scales not or scarcely enlarged. Limbs short, widely separated where adpressed. Digits cylindrical; subdigital lamellæ smooth, sixteen to eighteen under the fourth toe. Brown above, with a few darker dots; a dark-brown irregular dorso-lateral streak, edged above with yellowish; flanks with light dark-edged spots; lips mottled with dark-brown; throat spotted with dark-brown.

"From snout to vent, 59mm.; head, 11mm.; width of head, 7·5mm.; fore-limb, 12mm.; hind-limb, 17mm." *Boulenger.*

The tail is thick and short, as in the next species. *Hutton.*

F. Werner has recently described a species, *Liolepisma micans*, in the Verhandlungen d. k. k. zool.-bot. Gesellschaft in Wien, vol. xlv., p. 13. It is founded on a single specimen. From the description we can see no reason for not including it under *L. æneum.*

Distribution.—Both Islands, and Stephens Island. *Hutton.*

Sub-genus HOMOLEPIDA, Gray.

Limbs short, the hind-limb not measuring more than the distance between the anterior corner of the eye and the fore-limb, pentadactyle. Lower eyelid scaly. Tympanum distinct. No supranasals. Præfrontals well developed. Frontal not broader than the supraocular region.

Homolepida ornatum, Gray.

Hinulia ornata, part, Gray, Cat., p. 77. *Tiliqua ornata*, Gray, in Dieffenbach's "New Zealand," ii., p. 202. *Eupreues ornatus*, Steind., "Novara" Rept., p. 49. *Lygosoma ornatum*, Boulenger, Cat. iii., p. 317, pl. xxxii., fig. 1.

"Habit lacertiform, rather stout; the distance between the end of the snout and the fore-limb is contained once and two-fifths to once and two-thirds in the distance between axilla

and groin. Snout short, obtuse. Lower eyelid scaly. Nostril pierced in the nasal; no supranasal; frontonasal broader than long, forming a suture with the rostral and with the frontal; latter shield as long as frontoparietals and interparietal together, in contact with the two anterior supraoculars; four supra-oculars, second largest; six to eight supraciliaries; frontoparietals distinct, longer than the interparietal; parietals forming a suture behind the interparietal; one or two pairs of nuchals; fourth or fifth upper labial below the centre of the eye. Ear-opening oval, a little smaller than the eye-opening, without projecting lobules; twenty-eight or thirty smooth scales round the middle of the body; laterals smallest. No enlarged præanals. The adpressed limbs fail to meet or just meet. Digits subcylindrical; subdigital lamellæ smooth, eighteen or twenty-two under the fourth toe Tail thick, little longer than head and body. Yellowish or reddish-brown above, each scale with several fine darker lines; sides with dark-brown and yellowish markings; a yellowish dark-edged spot below the eye; lower surfaces yellowish, uniform or spotted with brown.

"Total length, 129mm.; head, 13mm.; width of head, 10mm.; body, 51mm.; fore-limb, 16mm.; hind-limb, 20mm.; tail (reproduced), 60mm." *Boulenger.*

In habit and coloration this lizard has a strong resemblance to *Liolepisma æneum.*

Distribution.—The neighbourhood of Auckland.

An enlarged palpebral scale, or small disk, is generally present. *Hutton.*

Art. XXII.—*Notes on the Cicadas of New Zealand.*

By A. T. Potter.

[Read before the Auckland Institute, 6th July, 1896.]

I have had good opportunities of observing the habits of a family of insects which numbers amongst its ranks some of the greatest noise-producers of the whole class—I mean the cicadas. I have so far had several species of these curious and interesting Homoptera, from both the South Sea Islands and this district, and have found that as soon as the sun gets hot the bush resounds far and wide with their ear-splitting sounds, which are certainly more vigorous than pleasing. Now, as is well known, these vocal powers, if I may call them so, are confined to the males, which of itself is a highly-

significant fact, and, apart from all other considerations, lends a distinct air of probability to the theories of those who believe in the auscultatory powers of insects. It is contended by some that the possession of a sound-producing apparatus is no proof of the ability to hear. I maintain that it is strong evidence in favour of that ability, and when such apparatus is confined to one sex the hearing-powers in the opposite sex become evident. When we come to examine the male cicada and see what a large part of it is occupied by the sound-producing organs, such a highly-specialised apparatus must be of importance in the welfare of the insect in which it occurs, and can only have been produced by some very potent factor. Now, as these sounds are emitted only by the male sex, my observations show me that the female seeks the male instead of *vice versa*, which I think is strong evidence that the female can hear, and is attracted by the song of the male. My notes have been made on only two species, which offer greater facilities for observation than the others, and even in these it is very difficult to make accurate observations, owing to the sluggishness of their movements, the height at which they sit, and the fact that the male and female are indistinguishable on the tree unless the male happens to be singing, when the abdomen is slightly raised and the wings held at a somewhat acute angle.

I have watched solitary males when singing, and seen another cicada advance from some other part of the tree with a slow, somewhat jerky gait, stopping every now and then, and passing and repassing the calling insect until it rests alongside him. On netting such insects I have found them to be females. I have noticed that when any females are near a calling male the latter becomes very restless, walking backwards, forwards, and sideways, and giving a sharp flutter with his wings as if to try and attract the attention of the females. If the male utters his shrill cry for the purpose of attracting the female, the explanation of the different calls of the species at once can be seen, for if the female finds the male by his call, and there are a number of different species frequenting the same place, those males which acquire some peculiarly distinctive sound would be likely to attract to themselves more females of their own kind, and thereby would leave more progeny, than those males whose cry more closely resembles that of another species, for these latter would be apt to attract females of another species, with which they could not interbreed; and those females which are most apt at distinguishing the notes of their own mates from those of other species are more likely to pair and leave progeny. I have several times imprisoned male cicadas in my breeding-cage, which is 4ft. by 2ft., in twelve compartments of gauze

and glass, to see whether they would attract females by calling, and have taken the cage into the bush. Unfortunately my experiments have failed so far, as the male has refused to utter a sound beyond an indignant squeak quite distinct from his usual call.

Cicadas do not seem to indulge much in flight, and, considering the numbers there must be about, I have seen very few on the wing except when they have been actually disturbed. Their sluggishness may be accounted for by the fact that these insects are perfectly defenceless, their only protection being their protective colouring, and their greatest safety lies in sitting still. The great majority of unarmed insects, which are well adapted to their surroundings, sit fairly close. This is the case with the cicadas. Several species will allow the branch on which they are sitting to be roughly shaken or even struck with a stick within a few inches of themselves without moving; and yet this is no proof that they have no sense of touch, for to such insects immobility is their safest course up to a certain point.

I cannot see that there is any impossibility for insects to possess additional senses which we have not. I need only mention one instance. It is well known that termites have no eyes, yet any one who has observed them will have noticed that they can perceive light—even to the slightest ray they show a strong dislike. Now, what is the name of the sense which enables them to do this? It cannot be sight, for they are blind; neither can it be any of the four senses as we understand them, for to our ideas light has no smell or taste, and is inaudible and intangible. I should very much like to see the solution of this problem.

Art. XXIII.—*Descriptions of Two New Species of* Lepidoptera.

By E. F. Hawthorne.

[*Read before the Wellington Philosophical Society, 9th September, 1896.*]

The two insects here described appear, on the evidence available, to be each eminently distinct from the previously known forms of their respective groups. For the purpose of facilitating identification, those words which are descriptive of the specially distinctive characters of each species are printed in italics.

CHARADRININA.

CHARADRINIDÆ.

Orthosia margarita, n. sp.

Male, female. 33mm.–36mm. Head, palpi, antennæ, and thorax fuscous, considerably darker in ♀. Abdomen grey. Legs fuscous mixed with pale-ochreous, tarsi dark-fuscous with apices of joints pale-ochreous. Fore-wings: Costa very slightly arched, apex rather obtuse; termen hardly waved, tornus obliquely rounded; in ♂ fuscous, considerably darker in ♀; a black spot just before first line below middle; orbicular stigma oval, oblique, light-brown, margined first with ochreous then with black; claviform stigma black, scarcely traceable in ♀; reniform stigma large, outlined with black and partially with dull-white; a costal series of small black spots; in ♂ a cloudy dark-fuscous costal shade just beyond second line, *subterminal line with long acute internal black dentations;* a terminal series of small black spots; cilia fuscous, darker in ♀. Hind-wings: *Pearly-white, semi-transparent, a narrow fuscous terminal band;* costal and dorsal regions lightly suffused with fuscous; *veins fuscous;* cilia white, with a faint smoky-grey line, suffused at apex with fuscous.

Wellington, in April; two specimens.

NOTODONTINA.

HYDRIOMENIDÆ.

Asaphodes siris, n. sp.

Female. 21mm. Head, palpi, and thorax pale brownish-ochreous. Fore-wings: Termen strongly sinuate; brownish-ochreous mixed with white; *basal patch and median band edged with dark-brown; posterior edge of median band with a strong broad median projection;* a small dark-brown discal spot; subterminal line obscure; cilia brownish-ochreous. Hind-wings: Pale-ochreous with a grey median transverse line; basal half lightly suffused with greyish; cilia pale brownish-ochreous.

Wellington, in March; one specimen.

Art. XXIV.—*Described Species of New Zealand* Araneæ *omitted from the Catalogue of 1891, "Transactions of the New Zealand Institute."*

By A. T. Urquhart.

[Read before the Auckland Institute, 5th October, 1896.]

I am indebted to Captain F. W. Hutton for the subjoined list of species described by Adam White in the "Proceedings of the Zoological Society," London, 1849, p. 3:—

Mygale (Cteniza) antipodum.
Mygale (Cteniza) zenops.
Dolomides sagittiger.
Dolomides lateralis.
Attus darwinii.
[*Attus abbreviatus*, Walck., and *A. cookii*, Walck., are also mentioned from New Zealand, and probably *Attus phrinoides*, Walck.]
Spharus gracilipes.
Tegenaria antipodiana.
Dendrulgia dysderoides.

Art. XXV.—*Natural History Notes.*

By S. H. Drew, Curator of the Public Museum, Wanganui.

[Read before the Wellington Philosophical Society, 22nd July, 1896.]

Wood-pigeon (*Carpophaga novæ-zealandiæ*).

A beautiful male specimen of our wood-pigeon (*C. novæ-zealandiæ*), with abnormal plumage, has been presented to the Wanganui Museum by Mr. T. Harper, of Mangamahu. Head, neck, breast, belly, and tarsi are quite of normal colour, but the mantle, wings, scapulars, back, and tail are white, shaded at tips of feathers to darkish-grey; ends of primaries and tail darker grey; a few darker feathers here and there on the back and secondaries and wing-coverts add to the beauty of this handsome bird.

Cnemiornis.

A box of moa-bones taken from one of the cuttings on the main trunk line near Hunterville, North Island, has been sent to our Museum by Mr. John S. Stewart. Amongst the many moa-bones I was pleased to notice the femur, tibia, and tarso-

metatarsal bones of the extinct goose, *Cnemiornis*. I do not know at what depth the bones were found, but the holes and grooves in all were filled with Tertiary marine shells and sand. It may also be interesting to say that in 1894 the Rev. A. O. Williams procured for us from Te Aute Swamp, Hawke's Bay, a quantity of moa-bones, amongst which I obtained a number of bones of *Cnemiornis* and also of *Cygnus sumnerensis*.

Moa remains.

The remains of a large moa have been brought to light from the old estuary gravel-pits of St. John's Hill, on the town side of the Wanganui River, and directly opposite the blue-clay bluff called Shakspeare Cliff. In May last the borough workmen reached a depth of 65ft. from the surface, finding the bones, which consist of a tibia, femur, and several of the vertebræ. They were very soft and brittle, and consequently much broken in the digging-out. The workmen state that there were a number of other bones, but far too soft to do anything with. It is interesting to note the occurrence of moa-bones in this district at this great depth, as hitherto such finds here have only been in the lighter surface-deposits.

Botaurus pœciloptilus.

To-day my son was dissecting a common bittern (*Botaurus pœciloptilus*) and called my attention to the undigested food it had eaten. We found the "bill of fare" for that day to have been a silver-eye (*Zosterops cærulescens*), frog (acclimatised from Australia), five locusts, a large spider, two common sand-liguras, remains of a small fish, &c. My experience of the bittern is that it will only feed on living animals, not eating anything dead. If so, it must have caught the silver-eye alive. No doubt the busy little silver-eye, intent upon its hunting, would gradually approach the motionless bittern, and thus fall an easy prey. It is well known that the bittern varies its feeding, but this is the first instance in my knowledge of a bird being found in its stomach, adding still another enemy to our useful little migrant blight-bird. From a bittern last summer we extracted seven mice, and from another a half-grown rat, besides other delicacies. In spite of this bird being so useful to the farmer it is ruthlessly shot, and, like the rest, will soon be a bird of the past. Twenty years ago it was very common in the swampy ground of this coast, but its slow, easy flight makes it a capital target for the cockney sportsman, who could not hit anything that rose faster. There are so many so-called sportsmen who will shoot at anything that flies that it is a question whether the introduction of foreign game has not had something to do with the extinction of some of our native birds.

Orthagoriscus mola.

In May last the Wanganui Museum was fortunate to secure an unusually large specimen of the sun-fish (*Orthagoriscus mola*). I received a telegram from Mr. Wilson Craig, of Napier, kindly telling me that a sun-fish had been captured in their inner harbour, and that he had purchased it for us. Mr. Charles Smith (who is one of the earliest members of this learned Society, and an indefatigable worker in the interests of our Museum) at once joined me and we started for our prize. We reached the Western Spit, Napier, early on Tuesday, the 5th of May, and found that the fish had been dead a week. The captors informed us the monster was seen to enter the inner harbour on the flood-tide near high-water. While it was in the deeper parts of the harbour little else was seen than the top of the upper fin, causing many to imagine it was either a very large shark or a small whale. Nearing Petane Bridge its progress was stopped, the lower fin touching ground in the more shallow water, causing the fish to lose its upright position; but, after much flapping of the huge upper fin, the strong tide forced the creature between the piles of the bridge, eventually stranding it about a mile further on. The spectators watched with great interest, and many were the opinions as to what the animal really was. A crew of Maoris were the first to attempt capture, but on near approach the wild movements of the upper fin caused so much fear that they beat a retreat. Two fishermen of the name of Boyd were the next to attack, and they killed the fish after much stabbing with manuka poles. I do not think I ever saw a specimen so mutilated. Every one with a pocket-knife seems to have hacked at it, and one piece of the side, weighing about 2cwt., was found fully a quarter of a mile up the beach. Even mementoes of the monster were taken, one woman getting a pectoral fin to dry for a fire-screen; and square pieces were cut out of the skin, in the same way as one sees a grocer cut a cheese for tasting. After the viscera were removed, and the 2cwt. piece mentioned above, the fish was taken to the weighbridge, and scaled 37cwt.; so that, had it been weighed when perfect, there is little doubt that it would have exceeded 2 tons. Its measurements as it lay on the beach were—Depth from tip to tip of fins, 12ft. 7in.; greatest length, 9ft. 8in.; greatest thickness, as near as I could tell, 1ft. 6in. The eyeball was 4¾in. in diameter, the iris being silvery blue, with darker blue and black markings. The colour of the skin when we saw it was grey, the fins being almost black; belly lighter grey. The fishermen said that the colour had not altered much, for when caught "it was a sort of dirty blacklead colour all over." There certainly were none of the reds mentioned by Couch;—possibly with age the red colour is lost. The men told us of the vast quantities of internal

parasites that infested this fish. They spoke of huge knots of tape-like worms as "big as two fists," masses matted together of round smooth worms of several kinds; and in the gills, mouth, or anywhere they could fasten were parasitical crustaceans, "flat, crab-like fellows with long tails." Unfortunately, these "beastly things" were carefully collected and thrown into the sea before we arrived, nor could they understand that we should wish to save such things. After gaining this small amount of information, we engaged three men, who with ourselves made a start to remove the skin This occupied three days, working all the hours of daylight. On Friday the work was sufficiently far advanced to get the skin into a cask, so that we could bring it and the skeleton home for further treatment. It was a most unpleasant task to all. It was not skinning as one would skin any other fish, mammal, or bird, but we found it was all the time cutting a hard gristly substance that very quickly turned the edges of the sharpest knives, blistering our hands that had already been made sore by the cutting roughness of the skin.

There being so many cuts as well as pieces missing, I found I could only mount it as a half-fish, so I patched up the one side with pieces from the other.

This fish seems to be one of the largest caught so far. Most of the books I have on this subject mention the British Museum specimen as of greatest size, but this only measures 8ft. 6in. from tip to tip of fins. Mr. Etheridge, the curator of the Australian Museum, Sydney, writes, "It may perhaps interest you to know that our largest specimen, stranded at Manly, Port Jackson, is 8ft. 3in. long by 11ft. deep—*i.e*, from tip to tip of fins."

Mr. Hamilton, in "Transactions of the New Zealand Institute," vol. xviii., page 136, gives the measurement of one stranded near Napier as 8ft. 1½in. in length.

Archdeacon Williams mentions a sun-fish in the "Transactions of the New Zealand Institute," vol. xxv., page 110, the total length of which was 9ft. 8in., and depth from tip to tip of fins 11ft. 6½in. The weight of this fish was guessed at 3½ tons, but I think this must be an error in judgment, as our larger fish weighed but little more than half.

The latest capture is the one in the Dunedin Museum. Mr. Hamilton has kindly sent me photographs, but not the measurements. I trust it will be noted in the Transactions.

Art. XXVI.—*On Formol for Preservation of Natural History Specimens.*

By S. H. Drew, Curator of the Public Museum, Wanganui.

[*Read before the Wellington Philosophical Society, 22nd July, 1896.*]

I find that some of my natural history friends are unacquainted with formol, and, as I have had several letters asking about my way of using this drug, it has been suggested that possibly a few short notes might be useful to others.

In October and November last, Mr. Charles Smith, of Te Korito, Wanganui River, and myself made a trip to New South Wales, principally to obtain skeletons and fishes for the Public Museum, Wanganui. Our object was to get as many of the more interesting specimens as we could in the short time available. We wanted to spend as much time as possible in the field, and as little time as possible preparing specimens afterwards. We wanted something that would preserve our specimens after they had been roughly and quickly cleaned, and at the same time we were anxious not to be hampered with heavy and cumbersome impedimenta. Alcohol meant all this, as well as another big item to us—expense. I had heard and read of formol as a very strong antiseptic, so we determined to risk it. Formol was not procurable in New Zealand, but we found it kept in stock by Elliott Brothers, Sydney, the cost being £1 10s. per gallon. We were told that it would be unsafe to put formol in tin vessels, but, using it in such weak solutions, we risked that also; and I must say here that our specimens, when we reached home, turned out all we could wish. Our first halt was made amongst the "lobster-pot" men at Port Stephens. Kerosene-tins are to be had everywhere in the colonies, so we decided to trust to getting these useful vessels. There were only about a dozen fishermen in this little hamlet, yet we found plenty of tins. We had divided our formol in quarter-gallon tins for convenience, and packed one in each portmanteau. This was all that was required, except the few tools wanted. I never travelled so lightly on a collecting-trip before. I carefully cut an oval hole in the top or lid of the tin, so as to get the widest hole for large fishes. Then we half filled the tin with a 5-per-cent. solution of formol. The fishes are roughly skinned—that is, we left much of the flesh in the fins and head, &c.—and, giving the skin a rub inside with arsenical soap, rolled it carefully up and wrapped it in a piece of

common calico, then packed it away in our tin. In this way we were able to pack away from fifty to a hundred skins of fish, &c., in one tin. We had rays, small sharks, &c., in numbers. An electric ray even is a very small quantity when prepared in this way. We filled up our tin until we could not press any more in, then the hole was covered with part of a mustard-tin flattened out, and soldered down so that there could be no fear of leakage. When two tins were finished in this way they were packed in a kerosene case, then labelled and shipped, and so on. With small fish, lizards, toads, frogs, &c., wanted for mounting, or small birds for skeletons, we only removed the viscera, and placed these small specimens amongst the other skins, of course wrapping each specimen in the calico to save rubbing. The insects, land-shells, &c., we soaked in formol solution a few days, then packed in a mustard-tin with wool, sending them at once home by the cheap "sample post." I can hardly describe my anxiety upon reaching home to see how my specimens would turn out, nor my delight on finding them quite fresh, and many with the colours good. We found the blues and pinks the first to go, particularly so with the Crustacea and Cephalopoda. Since my return, in my spare time I have mounted many of the specimens, and have many more to do, and I find that these specimens, put into formol, 5-per-cent. solution, last October, are just as easily worked now, in June, as they were in December last, although the solution has been unchanged during that period. I mean to say that they are still in the original solution in which they were first placed.

Mr. Etheridge, the curator of the Museum at Sydney, showed me some small fish and *Medusæ* that had been in bottles for three months in formol, 10-per-cent. solution, that looked far more fresh and the colours in better condition than one could possibly get with alcohol. I placed, in December last, our *Physalia*, with a small fish hanging in its tentacles, in a 5-per-cent. solution. The bottle has been standing on our Museum window ledge, in full light, for six months. The specimen has faded, yet much of the pretty blue is left, nor is it anything like so opaque as if treated with alcohol. Owing to this experiment I intend, as soon as our fresh supply of formol arrives, to treat all our what are called spirit specimens in this way, if for no other reason than that of saving expense.

To sum up, I think there is no comparison between formol and alcohol—first, the formol is very much cheaper, the quantity needed for a kerosene-tin of 5-per-cent. solution costing about 2s, for alcohol at least £1, and to this should be added the cost and great inconvenience of cartage and freight—not a small one when moving about; second, it does not

evaporate; third, there is no danger from fire—and this is an item, for people will smoke and throw matches about, and how impossible it is to keep everything covered up; fourth, it does not require expensive apparatus to contain it; fifth, it takes up very little room; and, sixth, I believe the results are very much better.

Art. XXVII.—*On some Tick-parasites of the Kiwi.*

By W. M. Maskell.

[*Read before the Wellington Philosophical Society, 20th January, 1897.*]

Plate XVII.

I have to bring under the notice of the Society two animals of the "tick" family, discovered upon native birds during the year. The first, on the North Island kiwi (*Apteryx mantelli*), was given me by Sir W. Buller, and came, as I understand, from the forest-ranges at the back of Mount Egmont. The other, on the South Island kiwi (*Apteryx australis*), was given to me by Sir J. Hector, and came from Dusky Sound.

These two forms belong undoubtedly to the genus *Ixodes*, Latreille, or true "ticks," as will be seen from the characters given presently. In this genus there is great difficulty in establishing specific characters, as almost all the organs are extremely similar in all the forms, and the differentiation of species, unless founded upon extremely minute points, has to depend a good deal upon size, colour, or the animal-host, none of which is, in my opinion, very reliable; for the size of a tick is often dependent upon the quantity of food it has taken, the colour is frequently deceptive, and some ticks frequent several kinds of animals. These pests are found in many lands, some on human beings, such as the Garapata, of South America; others on dogs, or sheep, or cattle, such as the dreaded and murderous cattle-tick, of Texas and Queensland.

The family *Ixodidæ* has been divided by some naturalists into various sections, such as *Ixodes*, *Argas*, *Amblyomma*, *Hyalomma*, &c. The distinctions relied upon, however, seem to be not altogether satisfactory, with the exception, perhaps, of *Ixodes* and *Argas*, the others being probably only sub-genera or varieties of *Ixodes*. The separation of *Argas* is founded upon two sufficient characters—first, the position of the mouth-organs, which are not protruded in front, but hidden beneath the body; and, secondly, the absence of a shield on the back of the head, which is very noticeable in *Ixodes*. Indeed, Mr. A. Murray puts the genus *Argas* into the Gamasidæ,

not considering it a true tick; other writers, however, do not take this view.

There is one point of interest in connection with our New Zealand forms of these parasites. I do not find that in other countries a true *Ixodes* is found on anything but mammals and reptiles: cattle, sheep, dogs, snakes, deer, &c., are the usual victims. Some species of *Argas* are found on birds. But all the ticks so far reported as probably indigenous to New Zealand and the neighbouring islands infest birds. In 1884 I reported a true *Ixodes* on the penguin, which Mr. T. W. Kirk afterwards found also on a gull. Mr. Kirk reported another in 1886 on the albatros; and now I have two more on the kiwi. It is a recognised fact, I believe, that ticks live amongst grass and trees as well as on animals, and attach themselves to an animal as it passes by. It is in this way that they spread so rapidly, and that a whole country becomes a nest of "tick-fever." I suppose that birds also pick up these parasites from the ground or from shrubs. In our forests, therefore, it is presumable that ticks exist pretty frequently, and that other birds may hereafter be found to harbour those undesirable guests.

Ticks are usually not attractive to the sight, irrespective of their propensities. Some, however, are ornamented in various ways, as, for example, the specimen of a cattle-tick from Natal which I exhibit to you this evening. If it were not that this (which is not the same as the Queensland tick) is a most diabolical brute, one might almost characterize it as handsome.

Order ARACHNOIDEA.

Sub-order ACARINA.

Family IXODIDÆ.

Genus **Ixodes**, Latr.

Body covered with a tough leathery skin, which, in the female, is capable of extension. Dorsum bearing, at the cephalic extremity, a more or less elliptical shield. Mouth-organs consisting of a tubular rostrum with two palpi, protruded in the adult in front of the head. Eyes absent. Feet, eight in the adult, six in the young; claw double, with a caruncle or pad beneath.

The distinctive characters of the genus, separating it from *Argas*, Latr., are the protruding rostrum of the adult, the dorsal shield, and the pad beneath the claws.

Ixodes apteridis, sp. nov. Plate XVII., figs. 1–6.

Female when full-grown reaching ⅛in., but the size is dependent upon distention with food; some specimens seen

are only about ⅛in. The colour, dorsally, is a dirty-white or very pale buff, with a slight nacreous tinge; ventrally, the same, or a little lighter; the dorsal cephalic shield is brown. The feet and the rostral palpi are orange, the rostrum itself pale-yellow.

The male may be recognised by its smaller size (about ⅛in.), its darker orange-red colour, and apparent absence of the dorsal shield, which, however, is represented by a protuberance of the same orange colour.

The skin of the female is marked with great numbers of very delicate transverse striæ, set close together; the shield is smooth, and exhibits no pits or spots. There are no hairs, either dorsal, marginal, or ventral, on the body. The dorsum has two longitudinal grooves extending from near the shield to near the anal extremity; ventrally there are two similar grooves and a median terminal shallow depression in which is situated a small tubercular anal organ. The feet are rather long and strong, seven-jointed, terminated by two slender claws having beneath them an elliptical pad. On each side of the body there is a large circular spiracle. There are no eyes. The rostrum is protruded, cylindrical, straight, covered with longitudinal series of small recurved hooks; the palpi are four-jointed, curved inwards, and slightly clavate, with a few hairs at the tip.

The mouth and foot of the male do not appear to differ from those of the female

Hab. In New Zealand, parasitic on the North Island kiwi (*Apteryx mantelli*). Found in the forest-ranges inland of Mount Egmont.

Ixodes aptericola, sp. nov. Plate XVII., figs. 7, 8.

Body of female reaching nearly ⅛in. in length. Colour a dull dirty yellow, both dorsally and ventrally, with a very small brown dorsal shield; feet and mouth-organs orange-red. Skin marked with numbers of transverse striæ, which are rather coarse and strong. There are two ventral longitudinal grooves, but apparently none on the dorsum. Feet and palpi as in *I. apteridis*, but the rostrum has only a few hooks at the tip and none on the shaft. The body has no dorsal, marginal, or ventral hairs, and the very small shield exhibits no pits or marks.

Hab. In New Zealand, on the South Island kiwi (*Apteryx australis*), Dusky Sound.

The large size, the colour, the absence of dorsal grooves and rostral hooks, and a few other particulars distinguish this from *I. apteridis*. It differs from *I. eudyptidis*, Mask. (1884), on the penguin, also found in Dusky Sound, in the absence of hairs on the body and of pits on the shield.

I imagine that both these forms are new; and, as remarked above, the occurrence of members of this genus seemingly only on birds in and around New Zealand is somewhat interesting.

EXPLANATION OF PLATE XVII.

Fig. 1. *Ixodes apteridis*, female, dorsal view, about seven times natural size.
Fig. 2. „ male, dorsal view, about ten times natural size.
Fig. 3. „ mouth-organs, magnified.
Fig. 4. „ rostrum, highly magnified.
Fig. 5. „ foot, highly magnified.
Fig. 6. „ spiracle, highly magnified.
Fig. 7. *Ixodes aptericola*, female, dorsal view, about five times natural size.
Fig. 8 „ rostrum, highly magnified.

ART. XXVIII.—*Further Coccid Notes: with Descriptions of New Species, and Discussion of Points of Interest.*

By W. M. MASKELL, Registrar of the University of New Zealand, Corr. Mem. Roy. Soc. of South Australia.

[*Read before the Wellington Philosophical Society, 20th January, 1897.*]

Plates XVIII.-XXII.

THE following paper contains, perhaps, fewer "novelties" than some of my former ones, but such species as *Lecanium mirificum*, *Inglisia fossilis*, or *Sphærococcus socialis* are as interesting as any yet known; and I think that if my identification of *Monophlebus burmeisteri* is correct, as I believe it is, we have here a valuable addition to our knowledge of Coccids.

I am greatly indebted to Messrs. Koebele, French, and Lea for the numerous specimens which they have sent me. Those from Mr. Koebele are especially interesting as showing the wide range of many species already known—*e.g.*, *Aspidiotus ficus* and *A. destructor*, *Parlatoria zizyphi*, *Eriochiton cajani*, *Icerya seychellarum*, &c. Some of these, such as *E. cajani*, *Ceroplastes rubens*, are doubtless indigenous in many lands; others, such as *A. ficus* or *P. zizyphi*, have probably been introduced by the modern extension of traffic. Fifteen of the species mentioned in this paper have been received from Mr. Koebele, from China, Japan, and adjacent countries: of these, I find that only three can be considered as new; but, in fact, the collection of Coccids in the extreme oriental region is

as yet only in its infancy, and there are surely many scores still to be discovered.

The appointment of Mr. Lea as Government Entomologist of Western Australia has naturally resulted in the finding of many Coccids, several of which are given in this paper and are very interesting Reverting to an old question of mine still unanswered, I should be obliged to any one who could suggest or explain how such a species as *Sphærococcus socialis* forms its gall.

In the "Berliner Entom. Zeitschrift," 1894, Mr. E. H. Rubsaamen has a paper upon certain Australian Homoptera and Diptera Much of this is taken up by rather rough criticism of some observations of Mr. J. G. O. Tepper, of Adelaide, as to which it may be sufficient to say that the critic would have done well to acquire some greater knowledge of Coccids than he appears to possess before he proceeded to vilify others. As regards the only Coccid in his paper with which I am connected, I cannot by any means accept his *Crocidocysta froggatti*, which is nothing but *Cylindrococcus amplior* of my paper of 1892 (mentioned without a name by me in 1891). Mr. Rubsaamen's fig. 19, in his pl. xv, of the adult female, is an extraordinary one, showing four distinct wing-cases. Probably these are intended to represent segments with processes such as are shown in my figures of *C. casuarinæ* (1891). When naming *C. amplior* in 1892 I stated that the female is exceedingly like that of *C. casuarinæ*, and the larva also. Mr. Rubsaamen's figures of his larva are almost exact copies, a little enlarged, of mine of *C. casuarinæ*, his figure of the gall is like those of both *casuarinæ* and *amplior*, and the details (feet, antennæ, &c.) answer entirely for either. I see absolutely nothing, either in his figures or in his description, to warrant the establishment of "*Croculocysta.*" It is to be observed that Mr. Rubsaamen, writing in 1894, appears to have been entirely unacquainted with any of my papers except that of 1891, and, indeed, attempts to make merry over poor Mr. Tepper, who had referred to my name, "*Idiococcinæ*," of 1892, which his critic knew nothing about.

There is a point in the paper just mentioned which is of greater importance. I mean the proposal to change Schrader's name, "*Brachyscelis*," to a new one, "*Apiomorpha*," on the ground that the former was employed by somebody in 1834 for something else. It is high time that this practice of upsetting on trivial grounds a well-established custom should be abolished. Convenience may dictate that when an author has invented a generic name previously appropriated he should be recommended to change it for another. But this should be done either by that author himself or during

his lifetime by another person with his consent. No man would be so rude as to disregard a civil remonstrance or refuse to make a necessary correction, and there could be no possible difficulty in finding the address of any systematist. But it is not right that one who has made a special study of any form, or group of forms, and who has inadvertently duplicated a name, should be deprived of the honour (whatever that may be) which should attach to his work. It is still more intolerable when the wrong is done to one who is dead. For the corrector, who may perhaps be partially or wholly ignorant of the subject itself, and simply a grubber amongst catalogues or antiquated books, poses henceforth as the real student, relegates the original worker to the secondary position of a synonymist, and parades, like the proverbial jay, in peacock's feathers. The thing is, indeed, becoming an intolerable nuisance, and in this particular case I strongly protest, on behalf of Schrader, who is long deceased, against his removal to an inferior position in favour of Mr. Rubsaamen, for the name "*Brachyscelis*" has been in common use for nearly fifty years, and Schrader's work has never, as far as it went, been found erroneous.

I do not desire to be understood to deprecate all and every wish for clearness and accuracy. When, in 1884 (Trans. N.Z. Inst., vol. xvii., p. 17), I objected to the use of the name "*Chermes*" in both *Aphididæ* and *Coccidæ*, and proposed to confine it to the *Coccidæ*, calling the aphids "*Kermaphis*," my argument was based on the fact that the two families are Homoptera, and closely allied; consequently confusion might very easily arise. But what confusion could there be between, say, a Mammal and a Crustacean, a Mollusc and a Conifer, or, as in Schrader's case, between a Chrysomelid and a Coccid?

Further, I agree that in the case of any species mentioned by various authors under various generic and specific names the credit should be given to the first describer. Thus Hartig, in 1837, described a Coccid as *Aspidiotus pini*. Signoret, in 1870, pointed out that it belonged to the genus *Leucaspis*. Rightly the insect has since been known as *Leucaspis pini*, Hartig. In the same way the insect described by Douglas as *Crossotosoma ægyptiacum* is now correctly *Icerya ægyptiaca*, Douglas. But if any one had objected to *Crossotosoma* merely as having been previously used it would have been an injustice to Mr. Douglas if, without his consent, he had been set down as merely a synonymist.

Mr. W. L. Distant, in the Ent. Mo. Mag., Jan., 1895, has some remarks on this matter which are eminently correct. Mentioning that the name "*Zygæna*" has been used in connection with both Insecta and Pisces, he says, "There is

nothing to prevent a collector of British moths, by the substitution of a name, from figuring as the creator of a genus of sharks." Really the thing will ere long be reduced to such absurdity that it will kill itself, and the sooner the better.

Recognising, as I do, the fact that this "priority" craze has been the outcome, to a great extent, of an "International Congress of Zoologists," held in Paris and Moscow (and Zurich ?) during the last few years, I yet venture to point out that science is essentially republican, not subject to the dictation or domination of anybody; consequently blind obedience to the orders of such a congress is not necessary. I find in a copy of the results of the congress, obligingly sent to me by my friend Dr. R. Blanchard, of Paris, the following dictum: "Every generic name which has been already employed in the same kingdom must be discarded." This, of course, permits any amount of duplication between the animal and vegetable kingdoms; and, in strict interpretation, it does not authorise any one except the original inventor to make alterations: yet from some such rule as this has come the mischievous system which I have referred to. In its actual wording the rule is unexceptionable; no author ought to select for a genus a name previously in use if he can help it. But this is not saying that another person has any right to correct such an error without the author's consent, and so to usurp credit which does not belong to him.

For myself, I intend to employ the name "*Brachyscelis*," Schrader, whenever it comes in my way to refer to the genus to which he gave that name.

Section DIASPIDINÆ.

Genus Aspidiotus.

Aspidiotus bossieæ, Maskell.

I find that the real colour of the female puparium in this species is snowy-white. The specimens from which I originally described it were obscured by fungus. Mr. French has sent me several during the year (on the same plant, *Bossiea procumbens*) which are not so covered, and they look as if coated with white sugar, with a small ring over the larval pellicle. They form quite a pretty microscopic object.

Aspidiotus ceratus, Maskell.

I have received specimens of this species from Mr. Lea, Western Australia. Some of the puparia have a slightly yellow tinge. Mr. Lea says, "Only one twig on a tree usually affected, but that twig densely covered."

Aspidiotus rossi (Crawford), Maskell.

This species is fast becoming cosmopolitan. It is found in

California, China, Australia, South Africa, and other countries, and has now reached New Zealand. Specimens have been sent to me by Captain Broun, on olive, from Whangarei. It is by no means particular as to either locality or food-plant.

Aspidiotus articulatus, Morgan, var. **celastri**, var. nov. Plate XVIII., fig. 1.

Puparium of female larger than that of the type; and the colours of the pellicles and of the secreted portion are rather brownish than greyish.

The adult female is also larger than the type, reaching a length of $\frac{1}{11}$in. The abdominal lobes and scaly hairs, the deep groove separating the thorax from the abdomen, and the prominent small subconical process on each side of the thorax above the groove are identical with those of the type. But there are four groups of spinnerets, as against two in *A. articulatus;* the upper groups have 6 to 8 orifices, the lower (which are long and narrow) 8 to 12.

Hab. At the Cape of Good Hope, on *Celastrus laurinus.* My specimens were sent by Mr. Lounsbury on a plant in the Museum herbarium at Capetown, collected in 1825.

Mr. Morgan, in his description (Ent. Mo. Mag., Aug., 1889, p. 352), does not make any mention of the small conical process or spine on the margin of the thorax of this species. This, however, appears to me to be a sufficiently important character, and its presence in the insect now under review is a strong incentive to me to make it only a var. of *A. articulatus*, in spite of the greater number of spinneret groups. There is something analogous to this spine in *Diaspis boisduvalii*, Signoret, but there it is much less conical.

In the Ent. Mo. Mag., Sept., 1896, p. 199, Mr. E. E. Green describes two new insects allied to *A. articulatus*, with figures, but he neither mentions nor delineates any marginal cones on the thorax.

Aspidiotus ficûs (Riley), Comstock.

This insect occurs in Japan, on *Quercus cuspidata*, and probably on several other plants. I have had specimens sent by Mr. Koebele during the year.

Aspidiotus destructor, Signoret. Plate XVIII., fig. 2.

Mr. Koebele sent me some leaves of *Celtis occidentalis* from Hongkong, on which were several insects which I cannot attach to any species except *A. destructor*, for the reason that the two median lobes are shorter and smaller than the next pair outside them. As the species is probably widely distributed in the tropics (at least, in the Oriental region), I give a magnified figure of the extremity to exhibit this cha-

racter. In size, colour, scaly serrated hairs, &c., the insects from Hongkong exactly resemble those on cocoanut from Mauritius and the Laccadive Islands. (See "Indian Museum Notes," vol. iii., p. 66.)

Aspidiotus setiger, sp. nov. Plate XVIII., fig. 3.

Puparium of female very dark-drown or intense dull-black; circular; convex; diameter, about $\frac{1}{11}$in. The larval pellicle is central, very small, forming a minute apical shiny-black boss. Texture of puparium thick and solid. On turning it over the inside is smooth and black, with reddish edge.

Puparium of male light-brown, subelliptical, flattish; length, about $\frac{1}{25}$in. Pellicle yellowish.

Adult female very dark-brown; form normal; length, about $\frac{1}{18}$in. Abdomen tapering, with rather wavy sides; terminated by six subequal lobes, the outer margins of which are sloping and very minutely serratulate; between the two median lobes are two short, slender, club-shaped organs, and above them four others longer and larger. The margin of the abdomen beyond the lobes is serrated and marked with many short, elongated pores set closely together. Between the lobes are some short, serrated, scaly hairs. Four groups of spinnerets: upper groups with 10 to 14 orifices; lower groups, 10 to 12. On the thoracic and cephalic regions there are several rather long hairs with tubercular bases.

Adult male unknown.

Hab. In Japan, on *Quercus*, sp. My specimens were sent by Mr. Koebele from Yokohama.

This insect approaches *A. rossi* in the form and colour of the puparium and in the abdominal lobes, but it is larger, and differs also in the club-shaped organs. The thoracic and cephalic spiny hairs appear to separate it from all known species.

Aspidiotus dictyospermi, Morgan, var. **arecæ**, Newstead.

This insect has been sent to me by Dr. Alcock, of the Indian Museum, on tea, in India: the exact locality is not mentioned. All the characters agree with Mr. Newstead's description.

Genus Diaspis.

Diaspis calyptroides, Costa.

During the year I have received from Dr. Alcock, of the Indian Museum, Calcutta, an insect on prickly pear from Southern India, which I found on examination to be identical with a form known as *Diaspis cacti*, Comstock (2nd Cornell University Report, 1883, p. 91). On further and closer scrutiny it appeared to me that *D. cacti* could not be speci-

fically separated from *D. calyptroides*, the differences mentioned by Comstock being, first, a slight variation of colour, and, secondly, slight variations in the spinnerets. I cannot help thinking that these are not specific differences, and I have frequently refrained from using them as such, and, indeed, have not always made them foundations even for varieties. Therefore I gave Dr. Alcock an identification of his insects as *D. calyptroides*, var. *cacti*, Comstock.

In 1893 Mr. Newstead described (Ent. Mo. Mag., 1893, p. 188) an insect on cactus from Demerara as *Diaspis opuntiæ* (a name which he afterwards changed to *opunticola*). I agree with Mr. Cockerell, who (Canad. Entom., 1894, p. 127) considers this as a variety of *D. cacti;* further, I believe that *D. opuntiæ*, Cockerell (Journ. Inst. Jamaica, 1893, p 256), is the same species. Probably climate, or a variation of the species of cactus on which the insects feed, may account for the small differences noticed, and I think the classification of the species may be taken as—

D. calyptroides, Costa, 1827; syn. *Aspidiotus echinocacti*, Bouché, 1833.
„ var. *cacti*, Comstock, 1883.
„ var. *opuntiæ*, Cockerell, 1893.
„ var. *opunticola*, Newstead, 1893.

Mr. Cockerell has priority for his variety, which was published before that of Mr. Newstead, so that the latter will disappear if the two are found to be absolutely identical. I may remark that my observations have been made upon type specimens of all except var. *opuntiæ*.

Diaspis amygdali, Tryon.

Specimens of this insect, which have been sent to me from Hongkong, on geranium, are identical with a form which Mr. E. E. Green sent me in 1893 on the same plant from Ceylon. At that time Mr. Green proposed to give the insect the name of *D. geranii*, and I am not sure that it may not very well be considered as a variety. But in his paper in "Indian Museum Notes," vol. iv., No. 1, p. 3, he mentions it as *D. lanata* (which = *D. amygdali*), and I will not now disturb the arrangement.

Genus PARLATORIA.

Parlatoria perpusilla, sp. nov. Plate XVIII., figs. 4–9.

Puparium of female waxy, dark-orange-coloured, semitransparent, very convex, the base circular and in some specimens with a slightly flattened margin, the form sometimes subspherical sometimes subconical and truncate; the height is equal to the base. The upper portion is frequently

marked with a reticulate pattern, which is more noticeable in the truncate than in the spherical specimens. The enclosed insect may be detected through the puparium, but it is impossible to make out with any approach to distinctness either of the two pellicles. Diameter of the base of the puparium about $\frac{1}{80}$in.; scarcely visible to the naked eye.

Puparium of male not certainly observed, but probably white and elongated

Adult female of normal form, the anterior portion smoothly rounded, the abdomen distinctly segmented and tapering. Colour dark-reddish-brown. Length, about $\frac{1}{80}$in. The margins of the anterior abdominal segments are somewhat truncate. The abdomen ends in the normal deep serrations of the genus, which extend along the whole margin, and between them many broad scaly hairs extending beyond the serrations and ending in distinct denticulations. There are no ...of spinnerets.

...male unknown.

In Western Australia, on a species of *Hakea*, which ...stead of leaves many cylindrical, rather thick, light- ...spikes with sharp points. My specimens were sent by ...ea, from Geraldton.

...his is the smallest Coccid known to me; the unaided eye ...only just detect on the greenish spikes of the plant some ...essively minute reddish specks, which are the puparia. I ...ave placed it in *Parlatoria*, on account of the deep serrations of the abdominal margin and the prominent denticulate scaly hairs; but the puparium is unlike any others with which I am acquainted, and the absence of spinneret-groups is also abnormal.

Parlatoria proteus, Curtis.

Mr. Froggatt has sent me specimens of this species, on *Pinus insignis*, from the Botanical Gardens, Sydney. They are slightly smaller than usual, a fact which may be attributed to the slenderness of the pine-needles. In other respects they perfectly agree with the type.

Parlatoria proteus, Curtis, var. **virescens**, var. nov

Puparium of female distinctly green in colour, the pellicles orange. The secreted portion is subelliptical, the pellicles comparatively small, terminal. Length, about $\frac{1}{18}$in.

Puparium of male green, elongated, subcylindrical; length, about $\frac{1}{25}$in.; pellicle dark-orange, small, terminal.

Adult female of normal subglobular form, dark-brown. Abdomen terminating in the usual six elongated lobes with a fringe of conspicuous broad serrated scaly hairs. Beyond the lobes on each side there is an exceedingly small and

short spine with a tubercular base. Four groups of spinnerets, each with 6 to 10 orifices.

Larva subglobular, dark-brown; length, about $\frac{1}{100}$in. Abdomen terminated by a minutely-serrated margin, on which are four small subcylindrical lobes.

Male pupa dark-red, elliptical; length, about $\frac{1}{40}$in. The abdominal margin exhibits six lobes and a fringe of broad scaly hairs as in the female.

The female puparium when overturned is seen to have two longitudinal keels, which form a deepish groove in which the insect lies.

Hab. In China, on *Myrtus*, at Amoy, and on *Camellia*, at Macao: the latter are somewhat smaller than the former. My specimens are from Mr. Koebele.

All the species of *Parlatoria*, with the exception of *P. zizyphi* and *P. perpusilla*, are difficult to differentiate. The colours of the puparium vary somewhat, and the present form, by its greenness, approaches rather to *P. myrtus*, Mask., 1890, than to *P. proteus*, in which the puparium is light-brownish-yellow; and in the smallness of the pellicles it also resembles *P. myrtus*. But I have preferred to attach it to *P. proteus*, on account of the small spine on the margin beyond the lobes, which entirely agrees with my specimen of that species, and also with a figure of it given by Comstock (2nd Cornell Report, 1883, plate iv., fig. 3). This spine is wanting in *P. myrtus* and also in *P. pittospori*, Mask., 1890, and it is replaced by a small lobe in *P. pergandei*, Comst., 1880.

It is possible that at a future time *P. proteus* may be taken as a type, as follows:—

P. proteus, Curtis, 1843.
" var. *pergandei*, Comstock, 1880.
" " sub-var. *camelliæ*, Comst., 1883.
" var. *myrtus*, Maskell, 1890.
" var. *pittospori*, Maskell, 1890.
" var. *virescens*, Maskell, 1896.

Parlatoria zizyphi, Lucas.

I have received specimens of this species during the year from Hongkong, on oranges, sent by Mr. Koebele. Evidently the insect is being rapidly spread over the world now by the extension of the fruit trade.

In connection with this point the following circumstance may be interesting, and also amusing, at least to economic entomologists. In my paper of 1895 I reported that *P. zizyphi* was found in Western Australia on oranges and lemons imported there from Sicily. The fruit sent to me by Mr. Lea was very thickly covered with insects—indeed, dangerously so;

and it appears that the Agricultural Department of Western Australia came to the conclusion that the interests of fruit-culture in that country demanded stringent measures. Therefore they prohibited, if not entirely, at least to a large extent, the importation of these fruits. In consequence, the price of oranges and lemons rose considerably, and as the climate is hot, and the goldfields population thirsty, there was some little trouble. A newspaper of Perth, the *Morning Herald*, sent a representative to interview a principal fruit merchant of that city, and to obtain from him his views on the matter. To the question, "What is your opinion regarding the regulations of the Bureau of Agriculture with reference to the importation of fruit?" the merchant, a Mr. Harris, gave the following reply: "Speaking from a common-sense point of view, I think them harassing and unnecessary. The authorities maintain that the regulations are made to protect the colony from the introduction of scale. In common with many other close observers, I believe that scale is no disease at all, but that it is produced by the dripping of moisture from the leaf on to the rind of the fruit. Crystallization is produced, and then animalculæ. Although unsightly, these do not affect the development or the flavour of the fruit, and when it is peeled the insect life ends." This almost inconceivable rubbish is printed by the newspaper in large type, and seemingly without any comment, and the intelligent reporter appears to have been perfectly satisfied that "close observers," who must of course be competent, believe fully in the generative powers of "crystallized dew"! Mr. Harris's views were naturally tinged by considerations of interest; but it is scarcely satisfactory that nonsense of the sort should be promulgated by the public Press. It will not in the least surprise me if some day we see in our own newspapers a paragraph stating that scale is now discovered to be no insect at all, but a product of the crystallization of water; and many people who dislike restrictive regulations which interfere with them will eagerly accept this view as another argument against scientific knowledge or authority.

Genus Mytilaspis.

Mytilaspis maideni, sp. nov. Plate XIX., figs. 1–8.

Puparium of female reddish-brown, usually straight, sometimes very slightly curved; convex, elongated, very slightly widened posteriorly. Only one reddish-brown pellicle is visible at the extremity, the second pellicle being covered with secretion; but this second pellicle is small, not extending more than one-third of the length of the puparium, and it is also smaller than the adult female. The puparium is marked by conspicuous and deep transverse corrugations

and grooves, which appear to be usually nine or ten in number. Length of puparium, about $\frac{1}{30}$in.

Puparium of male similar to that of the female, but smaller; length, about $\frac{1}{30}$in. In this case, of course, there is only a single pellicle, which is reddish-brown. The puparium is straight, convex, and deeply corrugated, and may be distinguished from that of the female (apart from the size) by the lighter colour of the corrugations, which are usually eight or nine in number.

Adult female dark-brown, elongated, of the normal form of the genus; length, about $\frac{1}{20}$in. The extremity of the abdomen is truncate, with nearly straight edge, bearing six very small nearly transparent lobes, each of which is subtriangular, with an indentation on each side: these lobes are placed rather far apart, and the two median ones are a little larger than the others. There are two rather broad conical short spines between each pair of lobes, and sometimes three between the second and third. There are no groups of spinnerets, but many single orifices. The anterior portion of the abdomen exhibits three conspicuous corrugations, each of which bears on the margin at each side three or four broad cylindrical hairs with serrated ends.

The male pupa is dark-brown. The adult male is red, of normal form; length, exclusive of the spike, about $\frac{1}{60}$in.: the spike is almost half as long as the body. Antennæ rather thick, with the normal ten hairy joints. Wings, feet, and eyes normal.

Hab. In Australia, on *Litsea* (or *Litsaica*) *dealbata.* My specimens were sent by Mr. Froggatt, from Ballina, Richmond River, New South Wales. I have the pleasure of attaching to it the name of Mr. J. H. Maiden, botanist to the Agricultural Department, Sydney.

This is an extremely pretty little species, and the deeply-grooved puparia are unlike any which I have previously seen. On the leaf sent to me there were many more males than females. In the appearance of only one pellicle on the female puparium the species approaches *Fiorinia*, but in that genus the second pellicle is much larger than the adult, and occupies almost the whole puparium.

Mytilaspis citricola, Packard, var. tasmaniæ, var. nov.

Puparia of both male and female not differing in any important particular from those of the type.

Adult female similar to the type, except that the third lobe on each side of the abdominal margin is rather more prominent, and that the spinnerets are more numerous: the upper group has 8 to 10 orifices, the upper laterals 12 to 15, the lower laterals 12 to 18.

Hab. In Tasmania, on *Pomaderris apetala.* My specimens were sent by Mr. H. S. Dove, who says that the insect is not plentiful.

Mytilaspis acaciæ, Maskell, var. **albida**, var. nov.

The puparia of this variety are lighter in colour than the type, being greyish-white. The median abdominal lobes are perhaps a little more prominent. In other characters I see no important differences.

Hab. In Western Australia, on *Acacia.* Specimens from Mr. Lea, who says, "Usually on trunk, very seldom on twigs, perhaps never on leaves."

Mytilaspis defecta, sp. nov. Plate XIX., fig. 4.

Puparium of female snowy-white, somewhat pyriform; pellicles yellow; texture loose; length, about $\frac{1}{28}$in.

Puparium of male similar, but more slender.

The puparia of males and females are frequently on separate twigs.

Adult female yellowish-brown, of normal elongated form; length, about $\frac{1}{30}$in. Abdomen destitute of lobes; the margin entire; the extreme median portion slightly produced. Five groups of spinnerets: upper group with three orifices; upper laterals, 7 to 9; lower laterals, 9 to 11. Within the margin, near the extremity, and on the margins of the anterior abdominal segments there are wide but shallow tubercular swellings covered with numerous large subcircular or oval pores, the two tubercles near the extremity being more prominent than the others.

Hab. In Western Australia, on (?). Mr. Lea sent me specimens from the Darling Ranges.

The absence of lobes and the marginal tubercles clearly distinguish this species and its variety next to be described.

Mytilaspis defecta, var. **tincta**, var. nov.

Puparium of female similar to that of the type, but slightly tinged with greyish-yellow, and also perhaps with a more solid texture.

Puparium of male as in the type.

Adult female as in the type, but the submarginal pores are smaller, and the tubercles less distinct.

Hab. In Western Australia, on *Hakea*, sp., the same spiky plant which bears *Parlatoria perpusilla.* My specimens were sent by Mr. Lea, from Geraldton.

Mytilaspis crawii, Cockerell, var. **canaliculata**, var. nov. Plate XIX., figs. 5, 6.

Puparium of female irregularly mussel-shaped, but the outline is indistinct, the whole being covered by a very thin scale

of the fluffy hairs from the surface of the leaf. Through this scale a narrow semicylindrical groove is visible, and on turning over the puparium the insect is seen occupying this groove, the pellicles being terminal. The whole is inconspicuous, being about the same colour as the leaf. Length, about $\frac{1}{16}$in.

Puparium of male similar to that of the female, but smaller. Length, about $\frac{1}{30}$in.

The adult female is yellow, exhibiting the very large median lobes, hairs, and deep indentations of the type. There are five groups of spinnerets: upper group with 2 to 3 orifices; upper laterals, 8 to 11; lower laterals, 5 to 6.

Adult male unknown.

Hab. In Japan, on *Quercus cuspidata.* My specimens were sent from Yokohama by Mr. Koebele.

Mr. Cockerell, in his description of *M. crawii,* in a paper published by the U.S. Department of Agriculture, 1896, entitled "Some Mexican and Japanese Injurious Insects," makes no mention of any groove in its puparium, and states that it has four groups of spinnerets. This last character is always somewhat variable, and perhaps in his specimens the two anterior orifices were absent. The groove may have been accidentally omitted by him. All other characters are absolutely identical with mine. Curiously, on the very same page of his paper he reports a grooved species from Central America, *M. carinatus* (*carinata?*), but that is clearly distinct in other particulars. I know of no other species with a similar groove except the male of *Fiorinia asteliæ.*

Genus CHIONASPIS.

Chionaspis aspidistræ, Signoret, and its allies.

In the "Entomologists' Monthly Magazine" for March, 1896, p. 60, Mr. Newstead discusses the affinities of *C. aspidistræ* and *C. brasiliensis*, Sign., concluding that the two are identical. In a paper sent to the same journal (see Ent. Mo. Mag., Oct., 1896, p. 223) I have expressed the view that, whilst possibly they may be of the same species, they are in all probability variations, and that as both were described by Signoret in the same paper (March, 1868) it may be convenient to consider *aspidistræ* the type, alphabetically. Since then I have been led to re-examine the two in connection with *C. theæ*, Mask. ("Indian Museum Notes," vol. ii., No. 1, 1891, p. 60), specimens of which were sent me this year by Mr. Koebele, from Formosa, on tea-plants. I have also re-examined specimens of *C. aspidistræ*, var. *mussændæ*, Green (Ind. Mus. Notes, vol. iv., No. 1, 1896, p. 2).

I do not find any important differences in the puparia of these forms. The male puparia of my Formosan specimens

of *C. theæ* are a good deal longer that those originally described from India. I cannot, therefore, now lay stress on any difference on this point.

As regards the "spinneret groups," the slight variations noticeable are not of specific importance. The numbers of orifices in these groups frequently vary considerably, even in specimens undoubtedly of the same species and taken from the same plant. Therefore nothing can be founded on this.

I find the marginal hairs varying slightly. In *aspidistræ* (type) there are on each side five or six, of which three are in an anterior group. In var. *mussændæ* I see ten on each side, with five in the anterior group. In *brasiliensis* there are three or four on each side, two in the anterior group. In *theæ*, the same as in *brasiliensis*. I am, of course, here speaking only of the hairs on the pygidial segment; all the forms have also hairs on the anterior abdominal segments.

The terminal lobes also vary. *Aspidistræ* and *brasiliensis* have two small median trifoliate lobes and two other smaller subcylindrical ones at each side; *theæ* has a small median depression; *mussændæ* has the two median lobes proportionately larger than those of the type.

Brasiliensis and *theæ* have less prominent segments than the other two, and, indeed, in the type *aspidistræ* the prominence is quite conspicuous and peculiar.

Size and colour I do not consider as really important points; but, in fact, there is not much difference as regards these in all the four.

On the whole, whilst I am still not prepared to entirely overlook the differences just noted, I have no objection to consider them as variations, and to classify the species as follows:—

C. aspidistræ, Signoret, 1868.
" var. *brasiliensis*, Signoret, 1868.
" var. *theæ*, Maskell, 1891.
" var. *mussændæ*, Green, 1896.

Chionaspis eugeniæ, Maskell.

This species seems to be widely distributed. The original specimens were Australian. I have had it since from China, Japan, and the Sandwich Islands, on many plants; and Mr. Green has two varieties of it in Ceylon.

Genus Poliaspis.

Poliaspis exocarpi, Maskell.

Mr. Lea has sent me specimens of this species on *Leptospermum*, sp., from Albany, Western Australia.

Genus FIORINIA.

Fiorinia camelliæ, Comstock, var. **minor**, var. nov.

This insect has been sent to me by Mr. Koebele, from Hongkong, on several plants, mostly palm. The specimens are smaller than usual, but otherwise present no distinctive features.

The species is common in many parts of Australia, from Sydney to Perth.

I agree with Drs. Berlese and Leonardi ("Chermotheca Italica," Fasc. I, No. 25) in considering *Fiorinia pellucida*, Targioni, as identical with *F. camelliæ*.

Fiorinia rubra, Maskell, var. **propinqua**, var. nov.

The puparia of this variety have rather more secretion than those of the type, and the general appearance is therefore lighter in colour. The terminal lobes of the pygidium are somewhat farther apart, and I have not detected dorsal spinnerets; but on the whole the characters are so near to those of *F. rubra* that I shall not consider it as a new species.

Hab. In Australia, on *Acacia*, sp. ("mallee"). Mr. French sent me specimens from Goudie, Victoria.

Fiorinia casuarinæ, sp. nov. Plate XIX., figs. 7–9.

Female puparium snowy-white, but the brown second pellicle may be faintly discerned through its not very thick or solid substance. Form very elongated and narrow; length, about $\frac{1}{12}$in. Of course only one pellicle is clearly visible dorsally at one end.

Male puparium similar to that of the female, but without any sign of a second pellicle Length, about $\frac{1}{16}$in.

Adult female brown; form normal, length, about $\frac{1}{40}$in. Abdomen terminated by a curve, without any lobes, and with only very minute marginal serrulations: at the extremity are two fine hairs. There are no groups of spinnerets, but there is a row of very small circular orifices just within the margin.

The second pellicle very nearly fills the entire puparium, and is therefore extremely long and narrow. The abdominal segments are rather distinct, and the last has a median depression, with the margin on each side broken by many deep conspicuous serrations, with two subcylindrical protruding lobes.

The male pupa is red, elongated, with the posterior abdominal margin resembling that of the second female pellicle, but the rudimentary wings, antennæ, and eyes distinguish it.

Adult male unknown.

Hab. In Australia, on *Casuarina*, sp. My specimens were sent by Mr. Lea, from Perth, West Australia.

This species, in the puparium, resembles *F. stricta*, Mask., but the absence of abdominal lobes in the adult separates it entirely.

Section LECANINÆ.

Genus Inglisia.

Inglisia fossilis, sp. nov. Plate XX., figs. 1–4.

Test of adult female glassy, extremely brittle, yellowish or brownish-yellow, elevated in a double cone whose apices are slightly divergent, the bases attached at one side, conspicuously marked with radiating striæ composed of rows of air-cells. From one apex to the other runs a deep narrow groove closed at the bottom with striated secretion, so that the insect cannot be seen within. In several instances there is only a single cone, and in these there is no groove, the cone being closed at the apex. At the base of the test there is a fragmentary small fringe, but this is often broken off. The base of the test has an average length of about $\frac{1}{4}$in., with a width of $\frac{1}{6}$in., and a height of $\frac{1}{8}$in. There is much black fungus accompanying the insects.

Test of male pupa not certainly observed; probably small, white, narrow, glassy.

Adult female dark-glossy-brown, conical, filling the test but shrivelling at gestation. The margin is slightly flattened, with usually a somewhat wavy outline. Antennæ and feet absent. Mentum doubtfully dimerous. Abdominal cleft rather wide and shallow; lobes normal; anogenital ring with several hairs, and above it a broad chitinous band nearly surrounding it. The margin of the body bears some very minute and inconspicuous conical spines, and there is a single median dorsal longitudinal row of small circular spinnerets.

Second female stage not observed.

Larva red or brownish-red, flattish, elliptical; length, about $\frac{1}{50}$in. Antennæ of six short thick subequal joints. Feet with the tibia slightly longer than the tarsus; the four digitules are long fine hairs. Margin bearing some small conical spines. Abdominal cleft small, lobes large, terminal setæ long.

Adult male unknown.

Hab. In Western Australia, on *Acacia*, sp. My specimens were sent by Mr. Lea, from the Darling Ranges.

This species is allied to *I. foraminifer*, Mask., 1892, but differs in the form of the test, in the absence of feet and antennæ, and in other particulars. It is viviparous, the female being usually full of larvæ. The length of the tibia in the larva is an exceptional character. The species is a large and handsome one.

The double cone of *I. fossilis* makes it approach in outward

form to *Fairmairia bipartita*, Signoret, a small and curious insect found on various plants in the South of France, and described in 1874. When, in 1878, I first established the genus *Inglisia* on a New Zealand species, *I. patella*, I was influenced principally by the air-cells which are conspicuous in the glassy tests. The test of *F. bipartita* is waxy, and I cannot detect air-cells in it. But these are constant in all the species of *Inglisia* which have been described since 1878, including *I. vitrea*, Cockerell, 1894, a West Indian species. The forms of the tests in this genus vary: some are almost semicylindrical (*I. leptospermi*, *I. inconspicua*, &c.), some singly conical (*I. patella*), some double (*I. fossilis*), so that there is nothing to be founded on this. But I think that the glassy structure and the air-cells may be considered as a sufficient basis for the genus.

Inglisia foraminifer, Maskell, var. **major**, var. nov.

Differs from the type apparently only in size, being rather larger, and in being perhaps rather greener in the colour of the test.

In 1892 I did not know the larva of this species. The larva of var. *major* is yellow, flattish, elliptical, active; length, about $\frac{1}{80}$in. Antennæ short, thick, with six joints. Feet long and slender; digitules all fine hairs. Abdominal cleft and lobes normal; setæ long. Fragments of a waxy test are visible on the margin.

Hab. In Australia, on *Muhlenbeckia adpressa*. My specimens were sent by Mr. French, from Swan Hill, Murray River.

Genus CEROPLASTES.

Ceroplastes rubens, Maskell, var. **minor**, var. nov.

Colours of insect and of waxy test as in the type; also the abdominal lobes, anal ring, cephalic papillæ and antennæ. The size is smaller; my largest specimens have a diameter of only about $\frac{1}{8}$in., whilst the type reaches $\frac{1}{4}$in.

Hab. In China, on *Pinus sinensis* and *Pinus thunbergii*. Specimens sent from Hongkong by Mr. Koebele.

C. rubens appears to be not uncommon. It is on several plants in New South Wales and Queensland, and I believe that Mr. Koebele has found it also in Japan and the Sandwich Islands.

Genus LECANIUM.

Lecanium oleæ, Bernard.

This species is very commonly known as the "black scale." These trivial names are by no means satisfactory. In the first place, there are many insects quite as black (or

rather brown, for *L. oleæ* is not really black); and, secondly, it is quite common to come across a twig with individuals of every shade on it, varying from dark-brown to quite a light-grey. In fact, the dorsal carinæ and the spots are the best characters for identification.

Lecanium patersoniæ. Plate XX., figs. 5, 6.

When describing this species in 1894 I had not the second stage of the female. Having received this during the year, I find that it is yellow, elliptical, flattish, with a length of about $\frac{1}{16}$in., and exhibits a submarginal row of pustules, as in the adult. But these pustules are different. In the adult they are multilocular, containing within the limiting ring several minute circular glands. In the second stage there is within the ring a single circular orifice, the termination of a short cylindrical tube. The figures which I give will illustrate this difference.

Lecanium longulum, Douglas. *Lecanium chirimoliæ*, Maskell.

This insect has come to New Zealand. Captain Broun sent me specimens on *Laurus*, from Northcote, near Auckland. It has evidently been imported from Fiji, between which place and New Zealand there is a rapidly-growing trade in fruit, &c. The species is widely distributed in tropical and subtropical lands. Whether it will spread to the colder parts of these Islands I do not know, but it will surely be found in greenhouses, and I make no doubt will establish itself in the warmer districts of the North Island.

Lecanium minimum, Newstead, var. **pinicola**, var. nov.

The type of this species is described by Mr. Newstead in the Ent. Mo. Mag., 1892, p. 141; it occurred in England on greenhouse plants, and therefore was presumably not a British insect. The specimens upon which I am founding my variety were sent to me by Mr. Lounsbury, from the Cape of Good Hope, on *Pinus insignis*, a tree not indigenous to South Africa. The insect therefore probably came originally from elsewhere. The variety agrees entirely with the type in size and colour, in the dorsal carina, in the antennæ and feet, and in the spines and hairs: it is a little more convex, but that may be accounted for by the extreme slenderness of the pine-needles. The principal difference is the absence of the "large and circular tessellation" on the epiderm, and this is not sufficient in my opinion to raise it to specific rank.

The larva (which was not described by Mr. Newstead) is yellowish, of normal Lecanid form; length, about $\frac{1}{50}$in. Antennæ short, thick, with six confused joints, the last of which bears several hairs, of which the terminal one is much longer

than the others. Feet rather swollen; digitules fine hairs. Margin of body minutely serrated. Terminal setæ rather long.

Lecanium berberidis (?), Schrank.

Mr. French has sent me some specimens of a very large *Lecanium*, on vine (*Vitis vinifera*), from Melbourne, which, after much consideration, I have decided to attach to this species. I have never seen the type, but Signoret gives a fairly full description of the insect (Ann. de la Soc. Entom. de France, 1873, p. 403). My specimens from Melbourne agree with the characters therein given as regards size, colour, dorsal carination, the sparse punctuation, the proportions and hairs of the antennal joints (almost), both of adult and larva, and in other characters. I think, however, that the fourth antennal joint of the adult is considerably longer than the fifth.

The principal difference which I can detect is in the feet. Signoret says that in the type of *berberidis* the tarsi of the anterior feet and the tibiæ of the median pair are considerably swollen. I do not see this in the Melbourne insects. But in the "Entomological Monthly Magazine," 1891, p. 267, there is a paper by Mr. Newstead on the alteration of some Lecanids by the action of parasites, in the course of which he says, "While some parasites may not materially affect the exterior of the scale, they are quite capable of malforming the antennæ and legs." I quite agree with this view, and it is partly on this account that I have (I think) never described a species without examination of several individuals, in order to ensure as far as possible having uninjured forms. It is quite possible that the malformation mentioned by Signoret in his European insects, and of which he says, "This is a specific character which I have seldom met with," may have been due to parasitism.

I have not seen any mention of *berberidis* by other authors since Signoret wrote, and it does not seem to be a British species. For the present I shall leave the insect with a note of interrogation. It is a large species, measuring about ¼in. in length, very convex, and in all probability would be very considerably injurious.

Lecanium baccatum, Maskell.

I have received several specimens of the second stage of this fine species from Mr. Froggatt, on *Acacia longifolia*, and from Mr. Musson, on *Acacia linearis*, both from New South Wales. These specimens, when they arrived alive, exhibited the beautiful bluish, almost nacreous, colour mentioned in my paper of 1892 (Trans. N.Z. Inst., vol. xxv., p. 217), but since they have been in my cabinet I find that they have lost

this colour and become whitish. As usual in the species, the males and females were on different twigs.

Lecanium mirificum, sp. nov. Plate XX., figs. 7–14.

Adult female dark-brown or yellowish-brown, but in the latest stage covered with a thin fragmentary coat of greyish, rather greasy wax. Form very convex, with a subcircular or subelliptical margin, the height in some specimens equal to two-thirds of the length. The size varies: early adults may average about ¼in. in length at the base, with a width of ⅙in.; fully-developed specimens reach a length of ⅓in., with a width of ⅓in., and a height of ¼in. The margin all round is somewhat flattened. The grey waxy secretion is not homogeneous, but composed of small adjacent greasy lumps. At the apex of the dorsum there are two rows of rather deep subcircular pits, the normal number of which is six, but some specimens exhibit only four. The abdominal cleft is normal, the dorsal lobes very small. On turning over an adult it is seen to be hollow, the cavity being filled with egg-shells. The antennæ have nine joints, of which the third is the longest, then the last, then the fourth and second, the rest being short and subequal; the first eight are cylindrical, the ninth irregularly fusiform. The feet, in the early adult stage, are moderately long; in the latest stage the two posterior pairs become somewhat atrophied; they present no special features: the four digitules are fine hairs. Mentum subglobular, monomerous. Anogenital ring with eight strong hairs. The margin of the body bears a row of shortish blunt spines. Epidermis bearing many small circular spinneret orifices, which are most numerous near the abdominal lobes; also great numbers of conspicuous irregularly-oval markings (as in *L. oleæ*), which apparently assist in the production of the dorsal wax. In mounted specimens of adult females the six apical pits may be clearly distinguished.

The second stage of the female is, in its early period, flattish, with an inconspicuous median longitudinal elevation, later it becomes more convex, and the dorsal apical pits appear. The colour is a rich-brown, dotted with yellowish small spots. Some specimens exhibit traces of thin disconnected dorsal wax. The length varies with age from about ⅛in to ¼in., the width from ⅒in. to ⅙in. The margin is flattened and bears short spines, which usually carry small coverings of white wax. The antennæ have eight joints, of which the sixth and seventh are the shortest, the third the longest: on the last are several hairs. Feet as in the adult, but the tarsus is quite as long as the tibia. Anal cleft and lobes, spinnerets, and oval markings as in the adult.

The newly-hatched larva has not been observed, but the

later larva is yellowish-brown, flat, elliptical; length, about $\frac{1}{15}$in. There is a dorsal longitudinal carina, and indications in some specimens of transverse carinæ. The margin bears spines as in the adult. Antennæ of seven or eight joints, according as we consider a division of the fourth a "false" or a "true" joint. Feet, anal cleft and lobes, and anogenital ring normal. There are many small irregular spots on the epidermis.

Male pupa covered by a white glassy test of the usual Lecanid form, composed of polygonal plates, flat at the top, with sloping sides and a subelliptical base. The length of this base is about $\frac{1}{20}$in.

Adult male not observed with certainty. One mutilated specimen (which had died when on the point of emergence) was extracted from a test. This specimen is brown, about $\frac{1}{25}$in. in length, exclusive of the spike, which is moderately long and slightly curved. A fragment of a wing is hyaline.

Hab. In Australia, on *Acacia pendula* (myall). Mr. French sent me several specimens which, he says, came from Goudie, "in the hottest and driest part of Victoria, where it is terribly destructive."

This insect clearly belongs to Signoret's fifth series of the genus, near to *L. cycadis* and *L. oleæ*, while at the same time it approaches my *L. scrobiculatum* in its dorsal pits. Its immense size makes it the largest *Lecanium* known to me. *L. tulipiferæ*, Cook, a North American insect, is the only one which approaches it in this respect; and even *Ctenochiton viridis*, hitherto quite the largest of the Lecanid group, is not its equal.

Genus PULVINARIA.

Pulvinaria nuytsiæ, sp. nov.

Adult female dark-brown, the form, as usual, elliptical at first but shrivelling at gestation, with an elongated narrow posterior ovisac of white cotton. Length of the insect averaging $\frac{1}{15}$in.; of the ovisac, $\frac{1}{4}$in. Dorsum elevated in a median longitudinal ridge, the margins flattened. Antennæ of eight joints, of which the third is the longest, the last three the shortest and subequal; the second bears one long hair, the eighth several short ones. Feet normal; the trochanter and femur have no hairs; tarsal digitules fine hairs; digitules of the claw widely dilated. Margin bearing a series of short blunt spines. Abdominal cleft and lobes normal. Mentum conical, monomerous.

Second stage not observed.

Larva yellow, elliptical; length, about $\frac{1}{40}$in. The dorsum is elevated in a conspicuous longitudinal ridge. Form Lecanid; abdominal cleft and lobes normal, setæ moderate.

Antennæ rather thick, with six joints. Margin bearing some short blunt spines. Spiracular spines rather long.

Male pupa covered by the usual white semi-glassy test formed of polygonal plates. Length of test, about $\frac{1}{16}$in. The enclosed pupa is dark-reddish-brown.

Adult male not observed.

Hab. In Western Australia, on *Nuytsia floribunda.* My specimens were sent by Mr. Lea, from Walkaway.

This species is allied to *P. maskelli*, var. *spinosior*, but independently of its much smaller size it differs somewhat in the feet, in the marginal spines, and in the dorsal elevation.

Section LECANOCOCCINÆ.

Genus Eriochiton.

Eriochiton cajani, Maskell, 1891.

This species, which I originally described in the "Indian Museum Notes," vol. ii., No. 1, p. 61, has been sent to me by Mr. Koebele, from Hongkong, on *Mallotus cochin-chinensis.* He tells me that it is also common there on many trees. I have no doubt that it is widely spead in tropical oriental countries.

In 1891 I was not acquainted with the male; but amongst the specimens from China I have found several. The adult male is dark-reddish-brown, rather large, reaching about $\frac{1}{25}$in. exclusive of the spike. Antennæ of nine rather long joints, the first globular, the rest slender, with several hairs on each. Feet long; tibia very long and slender; claw very small; digitules fine hairs. Eyes: four dorsal and two ventral; ocelli two. Wings with rather strong nervure. Abdominal spike slender, slightly curved, nearly as long as the abdomen.

Section HEMICOCCINÆ.

Subsection CRYPTOKERMITIDÆ.

Genus Mallophora, gen. nov.

Adult females covered by a closely-felted secretion. Insects exhibiting an abdominal cleft and lobes.

Male pupæ in tests usually more waxy than those of the females.

Larvæ naked, with prominent anal tubercles.

The sacs of this genus resemble those of *Eriopeltis*, *Philippia*, or *Signoretia;* but in those genera the larvæ are distinctly Lecanid, whereas here they are Coccid.

Mallophora sinensis, sp. nov. Plate XXI, figs. 1, 2.

Sac of adult female white, closely felted; the form is properly sub-semiglobular, but many individuals are usually so

massed together that it is difficult to distinguish them. For the same reason the length is not clear, but it may reach ⅛in. There are many longish, loose, glassy threads scattered over the surface.

Sac of male pupa elliptical, flattish, more waxy than that of the female. Dorsally there are two longitudinal depressions which give the sac a tricarinate appearance.

Adult female dark-brown, elliptical and convex, but shrivelling at gestation. Antennæ of seven joints, of which the third is the longest, then the fourth, the rest subequal; the last is irregular, and bears some moderate hairs, as also the sixth. Feet moderate; the digitules of the claw are slightly dilated; I have not been able to see any on the tarsus. The abdomen exhibits a distinct cleft, with two small triangular lobes; anal ring with six strong hairs. After treatment the ring frequently protrudes, as in some Lecanids. Margin bearing all round some longish spines. Epidermis covered with many large circular pores, and also numbers of tubular spinnerets of smaller size. Mentum monomerous.

Second stage of female not observed.

Larva yellowish-red, flattish, elliptical, active; length, about $\frac{1}{80}$in. Antennæ of six irregular confused joints: the last bears several hairs, of which two are much longer than the rest. Feet long, slender, with four fine digitules. Margin bearing all round a row of moderate spines. Abdomen terminating in two distinct protruding anal tubercles, each bearing a seta and some spines.

Adult male unknown.

Hab. In China, on *Callicarpa tomentosa.* My specimens were sent by Mr. Koebele from Hongkong.

There is no doubt, from the form of the abdomen in the larva and in the adult, as to the position of this species, and I cannot attach it to any known genus on account of the felted sac. I imagine that the small tubular spinnerets produce the felting, while the glassy threads may spring from the large circular pores.

Section COCCINÆ.

Genus PLANCHONIA.

Planchonia bryoides, Maskell, 1893, var. **stellata,** var. nov.

The female insect is almost exactly similar to the type, but the test differs in its more regularly stellate form, resembling in almost all specimens my fig. 3 of pl. v., Transactions, vol. xxvi., whereas in my original material the tests were almost all as in fig. 2 of the same plate. The antennæ and feet also are not entirely absent, the former being represented

by very minute tubercles which bear a few very short hairs, and the latter by equally minute sharply conical tubercles. The spinnerets, anal ring, and other features are identical with those of the type.

Hab. On *Exocarpus cupressiformis*, in the Cumberland district, New South Wales, Australia. My specimens were sent by Mr. Fuller, who informs me that the insect seems to be confined to that particular kind of tree, and that it has been long known in the district, where it goes by the name of the "star-scale."

I have no hesitation in attaching this to *P. bryoides*, while the differences noted are only sufficient to constitute a variety of that species, which came in 1893 from Fiji.

Planchonia quercicola, Bouché. *Asterolecanium quercicola*, Bouché.

I have received specimens of this on oak-twigs, from Sydney, sent by Mr. C. Fuller. They were in company with *Aspidiotus aurantii*.

Genus Prosopophora.

Prosopophora prosopidis, Maskell, var. **mimosæ**, var. nov.

The test of the adult female is rather larger and flatter than that of the type, but of the same colour and consistence: it has the same very indistinct appearance of segments and dorsal carina, and there is no depression in the twig when the insect is removed.

The adult female nearly resembles *P. prosopidis*, but is rather brown in colour than red. The antennæ, mentum, anal tubercles, spinnerets, and "discs" are as in the type.

Hab. In South Africa, on *Mimosa*, sp. Mr. Lounsbury sent me specimens.

There is nothing but the size and colour, as far as I can see, to distinguish this variety.

Genus Rhizococcus.

Rhizococcus casuarinæ, Maskell, var. **mancus**, var. nov.

Differs from the type in its slightly greener colour, and in having both the antennæ and the feet very small and almost atrophied.

Hab. In Australia, on *Casuarina distyla*. My specimens were sent by Mr. Froggatt.

This insect affects principally the axils of the twigs, and is usually doubled up and curved round the twig, so that it is very difficult to examine the ventral surface even after preparation.

Genus ERIOCOCCUS.

Eriococcus simplex, sp. nov. Plate XXI., fig. 3.

Sac of female yellow, but frequently obscured by black fungus; form elliptical; length, about $\frac{1}{30}$in., but variable.

Sac of male of similar form, colour white; length, about $\frac{1}{30}$in.

Adult female red; elliptical, filling the sac, but shrivelling at gestation. Antennæ of seven joints, of which the second and third are the longest. Feet normal. Anal ring with eight hairs. Margin of the body bearing a row of short blunt spines, which are rather slender; at the cephalic and abdominal extremities these spines are more numerous, and in groups. Epidermis bearing some circular spinnerets.

Adult male yellowish-red; length, about $\frac{1}{30}$in. Antennæ very short, with ten joints, of which the two first are thick and subglobular, the next three more slender, the sixth to the ninth widening consecutively, the tenth short and subconical; all the joints are hairy. The armature of the penis is very large, projecting considerably beyond the terminal abdominal tubercles, and produced into strong spines of considerable length.

Larva yellowish-red; form normal; length, about $\frac{1}{60}$in. Antennæ of six joints. Margin bearing small conical spines, and there is a double median dorsal longitudinal row of similar spines. Anal tubercles normal.

Hab. In Australia, on *Eucalyptus*, sp. My specimens were sent by Mr. Froggatt.

The adult female is not far removed from *E. spiniger*, Mask., 1895, but differs in the antenna, in the more slender spines, and in their arrangement in terminal groups. The larva, however, differs considerably in being much less spiny. As regards the male generative organ, I have not seen anything quite like it before in the genus, although I find that something analogous exists in *E. danthoniæ*, Mask.; and the antenna also is not quite normal.

Eriococcus simplex, Maskell, var. **dealbata**, var. nov.

Sac of female white; form elliptical; length, about $\frac{1}{30}$in., but variable.

Sac of male white; length, about $\frac{1}{30}$in.

Adult female and larva similar to those of the type. Only one specimen of the male observed, with the armature broken off.

Hab. In Western Australia, on *Eucalyptus*, sp. Mr. Lea sent me specimens, and says, "Seems to prefer the butts of red-gum trees which have been cut down, and from which young shoots are growing."

Although I have been unable to compare the male armature of this with *E. simplex*, I think I have rightly considered it only a variety, differing in having white instead of yellow cotton.

Eriococcus paradoxus, Maskell. Trans. Roy. Soc. South Australia, 1887–88, p. 104.

Specimens of this species sent by Mr. French, on *Pittosporum*, sp., from South Australia, have less agglomerated tests than those originally received, and here and there some whitish radiating waxy projections. The enclosed insects present no variations from the type. Some of the tests are tinged with green. I find that although the feet are absent their places are occupied by short, thick, conical spines, which I overlooked in my original description.

Eriococcus paradoxus, Maskell, var. **indica**, var. nov.

Tests of females agglomerated in a confused mass on the twig, similar in size and colour to the South Australian form, but covered with great numbers of very short reddish-yellow waxy filaments. The enclosed insect differs from the type only in size, reaching almost ⅛in., and in the greater number of the figure-of-eight spinnerets. In the type these are of two sizes, the smaller ones being scattered over the body, the larger usually confined to the last abdominal segment, but sometimes found elsewhere. In var. *indica* both large and small are mingled in great numbers over the whole body. The antennæ and feet are atrophied as in the type, the feet being replaced by conical spines.

Male and larva unknown.

Hab. In India, on *Helicteres isora*. Dr. Alcock sent me specimens from Saharanpur, North-west Province.

I have no hesitation in attaching this as a variety to the Australian species. I suppose that it is not at all likely to have been imported into India.

Genus Ripersia.

Ripersia turgipes, Maskell. *Eriococcus turgipes*, Maskell, 1892, Trans. N.Z. Inst., vol. xxv., p. 228.

Having received from Mr. Froggatt several specimens of this most curious species, on *Casuarina suberosa*, Sydney, Australia, I have been led to re-examine the characters, with the result that I have decided to transfer it from *Eriococcus* to *Ripersia*. The insect is abnormal in any case. In 1892 I mentioned two characters which seemed to separate it from *Eriococcus*—*viz.*, the six hairs of the anal ring and the long last joint of the larval antenna. These now seem to me

sufficient to remove it from that genus; and I will add the anal tubercles, which are more like those of a Dactylopid than those of an Acanthococcid. It does not entirely agree with *Ripersia*, on account of the shortness of the last antennal joint in the adult female; but *R. fraxini*, Newstead, has to some extent a similar character. The peculiar feet are unlike anything known to me in any genus; and, on the whole, the species is so abnormal that many entomologists would erect a new genus for it. However, I shall now place it in *Ripersia*.

Genus Coccus.

Coccus acaciæ, sp. nov. Plate XXI., fig. 4.

Adult female dark-red, with sometimes a lighter and yellowish tinge; semiglobular, segmented, often much wrinkled; diameter, about $\frac{1}{16}$in. When boiled in potash it produces a small quantity of dark pigment. Antennæ of six joints, the sixth the longest, the third next, the rest short and subequal; on the sixth, which is fusiform, there are a few short hairs. Feet rather long; tibia only slightly longer than the tarsus; all four digitules are fine hairs. Anal tubercles very small and inconspicuous; anogenital ring small, simple, hairless. Margin without spines or hairs; epidermis exhibiting only very few circular small spinnerets.

Second stage not observed.

Larva red, flattish, elliptical, active; length, about $\frac{1}{60}$in. Antennæ of six short joints, as in the adult. Feet normal. Anal tubercles prominent but small, bearing a few short spines; setæ moderate.

Male unknown.

Hab. In Western Australia, on *Acacia*, sp. (a plant with very small leaves and many slender thorns). Mr. Lea sent me specimens from Perth.

This is the first species of the genus *Coccus* which I have yet reported. Indeed, there are very few known. The absence of anal tubercles and of hairs on the anogenital ring is a distinguishing character.

Coccus cacti, auct., var. **ceylonicus**, Green. Ind. Mus. Notes, vol. iv., No. 1.

I have received this variety from Dr. Alcock, of Calcutta; the specimens were on *Cactus*, sp. (prickly pear), from the Kurnool and Amantipur districts, India. Mr. Green gives only a very brief account of it in the "Indian Museum Notes"; his detailed description is, I believe, in the press (1896).

Genus Dactylopius.

Dactylopius ceriferus, Newstead. Ind. Mus. Notes, vol. iii., 1894, p. 24.

I have this species from Japan, China, and the Sandwich Islands, on *Psidium* and other plants, sent by Mr. Koebele.

Mr. Green mentioned, in Ind. Mus. Notes, vol. iv., 1896, p. 6, a species, *D. talini*, which he since considers identical with *D. ceriferus*. Mr. Newstead separates his insect from *D. filamentosus*, Cockerell, only by the eight-jointed antenna. I think that this is scarcely sufficient, seeing that some species of the genus vary in this respect. But the characters of the feet, and the apparent absence of glassy filaments from *D. filamentosus* (in spite of its name), would be distinguishing characters.

No mention is made by Mr. Newstead of the male, nor by Mr. Green up to the present time. Amongst a mass of females from Japan I found one mutilated male. The colour is brown, with iridescent wings; the antennæ have ten joints, the last of which bears three knobbed hairs; the posterior setæ are very long, two from each side; and the sheath of the penis is short and subconical.

Dactylopius aurilanatus, Maskell.

During a late visit to Auckland I found that this species has spread and increased with terrible rapidity, and that it is doing immense mischief to all the varieties of *Araucaria* in that place. Indeed, many fine trees have been hopelessly injured by it, especially in the gardens of Government House. The species has also spread to California.

Dactylopius sacchari, Cockerell. Jour. Trinidad Field Nat. Club, 1895.

In June, 1896, Mr. Lounsbury forwarded to me from Capetown some Coccids, as to which he desired my opinion. They had been sent to him from Mauritius, by Mr. Nash, manager of the Oriental Estates Company in that island, on pieces of the root of sugar-cane. It appears that these insects are usually in company with *Icerya seychellarum*, and the two species are confounded by the residents under the name of the "Pou blanc." Both have white cottony secretion, but, of course, are quite distinct. It is not easy, in view of the confusion which has thus grown round this name, to make out whether the injury done to the cane by Coccids is to be set down in any great extent to the work of the *Dactylopius;* but, as will be seen presently, if we judge by its effects elsewhere, probably this insect is only responsible for the smaller portion of the harm done, and the *Icerya* is the principal offender.

When I first received these specimens I thought (and so informed Mr. Lounsbury) that they would prove to be a variety of *Dactylopius calceolariæ,* Mask., an insect which has been found attacking sugar-cane in Fiji and in the West Indies. But after carefully examining them again with a view to this paper I am convinced that they are *Dactylopius sacchari*, Cockerell, first reported on sugar-cane in Trinidad. Mr. Cockerell received his specimens in alcohol, and therefore makes no mention of the lateral cottony tassels which this species, like most of the genus, exhibits, and which are clear in my specimens. These tassels appear to be, on the average, fourteen on each side, those on the abdomen rather the longest. In length and colour the insects agree with *D. sacchari;* also in the seven-jointed antenna, in the relative lengths of the joints, in the hairs on the trochanter, in the digitules, and in other characters.

I regret that Mr. Cockerell makes no mention of the larva. In this stage the insect is reddish-brown or yellowish-brown, flattish, elliptical, segmented; length, about $\frac{1}{68}$in. The antennæ are long and thick, of six joints, which may easily be taken for four; the sixth is much the longest, fusiform, with several hairs; the fourth and fifth are the shortest. Feet also long and thick; tarsus one-third longer than the tibia; digitules all fine hairs. Anal tubercles very inconspicuous and small, with some moderate hairs.

I do not know the male.

Apart from its size (both adult and larva being very much smaller) this insect differs sufficiently from *D. calceolariæ* to form a valid species. The characters of the antennæ and the feet are quite distinct, and may be relied on for separation. Mr. Cockerell says that *D. sacchari* in Trinidad is "not seriously harmful", and, as remarked above, perhaps the same may be the case in Mauritius. The real "Pou blanc" which does the mischief will be the *Icerya*.

In Mr. Lounsbury's letter to me he mentions that specimens of this species had been sent to Miss Ormerod, who had forwarded them to Washington. In "Insect Life" (a journal whose demise I for one very deeply regret), vol. vii., p. 430, I see that "Miss Ormerod sent specimens of *Coccidæ* from the Oriental Estates Company, in Mauritius. One proves to be *Icerya sacchari* . . . upon sugar-cane, however, was found another Coccid, which proves to be a species, probably new, of the genus *Westwoodia*." At the same time some doubt is expressed whether this *Westwoodia* might not have been mistaken for an insect on guava, sent with the others. In any case it cannot be that the phrase just quoted refers to our insect. *Westwoodia* has antennæ of eight joints, not only in the adult female, but also in the larva. Whether, indeed,

it is a valid genus I am not prepared to say, never having seen it. But there is no character in these specimens from Mauritius which seems to me sufficient to remove them from the genus *Dactylopius.*

Dactylopius calceolariæ, Maskell, var. **minor**, var. nov.

Adult female thick and subglobular, reddish-brown in colour, covered with moderate meal, which in the specimens sent is yellowish, but as they came in alcohol it is difficult to say whether in life the meal is white or whether there are any lateral tassels or not; length of insect, about $\frac{1}{16}$in. Antennæ of eight joints, the eighth the longest, then the second, then the first and third equal, the rest shorter and subequal. Feet rather long and slender; tibia slightly dilated at the tip, and about twice as long as the tarsus; claw slender; tarsal digitules fine hairs, digitules of claw very slightly dilated. Anogenital ring normal, with six hairs; anal tubercles inconspicuous. Epidermis bearing some small circular spinnerets and a few conical spines.

Larva yellow or yellowish-brown; length, about $\frac{1}{48}$in. Antennæ of six joints, of which the last is the longest, and fusiform, the rest short and subequal. Anal tubercles very small and inconspicuous.

Adult male unknown.

Hab. In Mauritius, on roots of "onion-grass." Mr. Lounsbury sent me specimens received by him from Mr. Nash, of the Oriental Estates Company, sent together with those of *D. sacchari.* It appears that these also were included under the name of the "Pou blanc," so that probably the secretion on the adult female is in life white.

This is much nearer to *D. calceolariæ* than is *D. sacchari;* and, indeed, there seems to be little except size to separate it. I find that in my specimens of *calceolariæ* the sequence of the antennal joints varies a little, so that no distinction can be founded on that.

Section IDIOCOCCINÆ.

Genus Sphærococcus.

Sphærococcus rugosus, sp. nov. Plate XXI, figs. 5, 6, 7.

Females inhabiting galls of a dark-green colour, which are attached by a very short stalk to the leaves of the plant, though rarely a few are attached to the twigs. The gall is subglobular, produced at the end in a small cone; the surface is very conspicuously wrinkled all over. No orifice is visible at the apex of the cone. The average diameter of the gall is about $\frac{1}{8}$in.

Male gall not observed.

The adult female is dark-red, and when boiled in potash produces much red. Form globular, filling the interior of the gall, with a small quantity of white cotton or meal surrounding the insect. All the organs have disappeared with the exception of the rostrum and spiracles; the former is very small, the mentum atrophied but apparently dimerous; the spiracles are tubes dilated at each end. There are some small circular spinnerets and some short hairs, which are most numerous near the abdominal extremity; in fact, the insect is no more than a bag containing eggs and larvæ.

Second stage not observed.

Larva yellow, elongated elliptical, tapering posteriorly, active; length, about $\frac{1}{80}$in. Antennæ of four (?) joints, very short; the last is the longest, and is dilated towards the tip; it bears a few hairs, of which two are very long. Eyes conspicuous, black, tubercular. Feet rather long; femur thick; tibia and tarsus slender, claw very slender, digitules four fine hairs, those of the tarsus being very long The abdominal margin bears a few spines, and at the extremity are the usual two long setæ, with two small tubercles between them.

Male unknown.

Hab. In Western Australia. My specimens were sent by Mr. Lea, on *Leptospermum*, sp., from Mount Barker. In his letter Mr. Lea says, "The insect is not common." But the larvæ from the galls which I received are exceedingly numerous, and I have not noticed any parasites, so that I should have imagined the species would be widely distributed had he not stated the contrary.

In the absence of almost any organs whatever on the adult female it is difficult to compare this insect itself with any other; but I think we may consider it distinct, on account of the gall.

Sphærococcus rugosus, Mask., var. **elongatus**, var. nov. Plate XXI., figs. 8, 9.

Adult females inhabiting dark-green galls, which are attached by very short stalks, or are more commonly sessile, on the leaves of the plant: none were observed on twigs. The gall is fusiform, conspicuously wrinkled, and there is no orifice at the tip. Average length of a full-grown gall, about $\frac{1}{8}$in., the diameter about $\frac{1}{12}$in. Galls may be attached to either the upper or the lower side of a leaf; in either case a small orifice leading into the gall is visible in a small pit on the other side of the leaf.

Male pupæ in galls similar to those of the females, but smaller, more cylindrical, yellowish or brownish, and somewhat less wrinkled.

Adult female and larva not differing appreciably from the type. The larva may be a very little smaller, but is otherwise identical, and as the adult has no organs whatever for comparison it may also be taken as identical.

Male unknown.

Hab. In Western Australia, on an unknown plant with small but broad leaves and clusters of small white flowers. My specimens were sent by Mr. Lea, from Albany.

The only difference which I can detect between this and the Mount Barker insect is the more elongated form of the gall; and the absolute similarity between the larvæ is a very strong indication of specific identity.

Sphærococcus pulchellus, sp. nov. Plate XXI., figs. 10–13.

Adult females covered by a waxy test, which is of a very pale-yellow or buff or whitish colour. The form of this test is peculiar, and it is difficult to describe it in words; the figure which I give of it will best exhibit it. It is very convex, and is attached to a twig, either singly or in clusters, by an elliptical base, from which the sides swell upwards and outwards, with broad and shallow corrugations, like the two parts of a bivalve shell, not quite meeting at the top, but leaving a longitudinal slit through which may be seen an inner shell of the same material; sometimes this slit is very narrow, and the sides seem to touch, but a slight pressure shows that they are separate. In the great majority of specimens there is also another transverse groove, wider than the longitudinal one, but this is absent in some. On the whole, the test looks as if it were double, with the outer part cleft in two directions, but it is not easy to give an idea of its peculiar form in words. The average length of a test is about $\frac{1}{12}$in., but some specimens reach $\frac{1}{8}$in.

The test of the second stage is not unlike that of the adult, but whiter in colour and less solid.

Test of male pupa not observed.

Adult female subglobular, black in colour, filling the test. Antennæ and feet entirely absent. Mentum conical, monomerous. Dorsal epidermis covered with many small tubular spinnerets, which are most numerous near the margins, and along the margin runs a broad band, apparently chitinous, in which are large numbers of oval marks, each having a small circular orifice in the centre; towards the abdominal extremity there are three of these bands.

In the latest second or earliest adult stage the insect is similar to the adult, but smaller. Remains of antennæ and feet may be detected. The tubular spinnerets are more numerous, but the marginal bands have not yet appeared, nor the oval pores.

Larva not observed.

Adult male unknown.

Hab. In Western Australia, on (?). Mr. Lea has sent me many specimens from the Darling Ranges, and says, "Common all over south-west Australia, in the vicinity of swampy ground."

As regards the insect itself, this species is much like most others of the genus, simply a bag containing larvæ. The marginal bands distinguish it somewhat, but the principal feature is the very curious and decidedly pretty test, quite unlike anything else known to me.

This is the species from which I bred a parasite, which Dr. L. O. Howard has made the type of a new Hymenopterous genus, under the name *Anysis australiensis*. At the time when I sent him the insect I had not determined exactly the genus of the Coccid host, thinking that perhaps it might be allied to *Eriococcus*. I have since made up my mind on the point, as above.

Sphærococcus socialis, sp. nov. Plate XXII., figs. 1–7.

Insects inhabiting galls attached to twigs. The galls are globular, of a greyish or greyish-green colour; the size varies, some being scarcely larger than a large pin's head, others reaching a diameter of ½in. The outer surface is formed of very closely imbricated scales, which are apparently aborted and coalesced leaves of the tree. The structure of the gall is not hard, solid, or woody, but loose, and on cutting it open there is seen to be a central shaft from which others more slender branch off in every direction, the ends of these expanded in small fan-shaped or cordate recurved plates, the imbrication of which forms the outer wall of the gall. It results from this arrangement that the interior of the gall consists of a number of hollow cells, which contain the Coccids; these cells and the central shaft are covered with a coating of white meal. A gall may contain several adult female Coccids, besides some male pupæ in sacs, and many larvæ, each gall forming, in fact, a complete colony of families. There is no orifice visible on the outside at any part.

Adult female dark-red, globular; diameter, about $\frac{1}{20}$in. Individuals which have been parasitised are white. The antennæ are very small and atrophied, and seem to have only one, or two, joints, with some fine hairs at the tip. Feet entirely absent. Rostrum rather large, mentum doubtfully dimerous. Spiracles large, tubular. At the abdominal extremity is a very small simple hairless anogenital ring, with six very short fine marginal setæ near it. On the dorsum the segments are marked by transverse rows of very fine short

hairs with minute tubercular bases, and there are some simple circular spinneret orifices.

Female of the second stage elliptical, brownish-red, about $\frac{1}{80}$in. in length; flat beneath, convex above. Antennæ as in the adult; feet absent. The dorsum is covered with numbers of very minute pustules.

Larva reddish-brown or yellowish-brown, active, elliptical; length, about $\frac{1}{55}$in. Abdomen terminated by two very minute and inconspicuous anal tubercles, with very short setæ. Antennæ conical, with rather confused joints, which may be five or six; the last joint bears two long hairs. Feet rather thick; claw strong. I have not been able to detect any digitules. Eyes very small, black, tubercular.

Male pupa enclosed in a small, white, cottony, cylindrical sac, within the gall; length of the sac, about $\frac{1}{20}$in.

Adult male dark-red, wings grey; length of the body (exclusive of the spike), about $\frac{1}{40}$in.; the spike is excessively long, in some cases quite twice as long as the rest of the insect, and the penis still longer. The last abdominal segment is cylindrical, and the spike which issues from it is composed of several long, tapering, apparently telescopic joints. Antennæ of ten sparsely-haired joints, the first two short and subglobular, the rest long and slender. Feet not presenting any special characters; there is a terminal spur on the tibia.

Hab. In Western Australia, on a Myrtaceous plant, either *Melaleuca* or *Calothamnus*. Mr. Lea has sent me a large number of specimens, from Geraldton, and says, "There are acres of this." I am indebted to Mr. J. H. Maiden, of Sydney, for identification of the plant, and also for deciding the character of the galls, as to which I was at first uncertain whether they were not aborted seed-vessels. Mr. Maiden says that the fruits are not imbricated, and are open at the end. The galls must therefore be leaves aborted and agglomerated by the Coccids, and I suppose that the central shaft and radiating bars represent the twigs and leaf-stalks.

The adult male of this species resembles, in the very elongated and attenuated spike, that of *Sph. pirogallis*. Since establishing this genus in 1891 I have refrained altogether from defining any generic characters for the males, although I have now four species of that sex. I cannot consider the spike as characteristic, for a similar organ is apparently found in *Ascelis præmollis*, Schr., *Opisthoscelis spinosa*, Frogg., and *O. verrucula*, Frogg.; moreover, in *Sphærococcus styphelia* the spike is very short. I must therefore still leave the males generically undefined.

Section MONOPHLEBINÆ.

Genus MONOPHLEBUS.

Monophlebus burmeisteri, Westwood—Arcana Entom., 1841, 1, 22, 4; Signoret—Ann. de la Soc. Entom. de France, 1875, p. 364. Plate XXII., figs. 8–16.

Adult fomale brown, but covered with a dense pubescence of short and long hairs, so that the general appearance is greyish. Form elliptical, thick, segmented, as usual in the genus Length varying from $\frac{1}{8}$in. to $\frac{1}{4}$in., but shrivelling at gestation. There is a good deal of very white cotton on most specimens. Antennæ with nine subequal joints, the third and ninth rather the longest; the ninth is fusiform; all the joints beâr some short hairs. Feet long, black; tibia a little more than twice as long as the tarsus; trochanter with two long hairs, one longer than the other; the inner edges of both tibia and tarsus bear several spines. Rostrum large; mentum conical, dimerous. The dermal pubescence consists of immense numbers of short hairs and a good many much longer, interspersed with numerous small circular multilocular spinneret orifices. Anogenital ring without hairs; there are two longish terminal setæ.

Second female stage not observed.

Larva greyish-brown, elliptical, active; length, about in. Antennæ black, thick, with five joints, of which the fifth and the third are the lougost; the fifth is broadly fusiform, and bears several long thick hairs. Feet black, the tibia and tarsus are subequal, the tarsus a little the longer; both bear many hairs; there is only one digitule, which is a thick short bristle on the claw. Mentum long, conical, dimerous. The body is covered with a dense pubescence of short hairs, and the margin bears many longish setæ, which are most numerous and longest at the posterior extremity.

Eggs large, at first yellow, later dark-brown.

The male pupa is contained in a cylindrical sac of rather solid white cotton, the anterior end rather truncate, the posterior end regularly curved. Within the cotton the skin or case of the pupa is thin and transparent, covered with great numbers of short hairs interspersed with circular multilocular spinnerets. After the adult has emerged the exuviæ of the pupal antennæ and feet are dark-brown. The antennæ have six joints, of which the third and sixth are the longest; the sixth is fusiform. The feet are as in the adult female, as also the rostrum and mentum. Eyes tubercular and smooth.

The adult male has a length of about $\frac{1}{8}$in. for the body, with an expanse of wings of about $\frac{1}{3}$in. The head and thorax are very dark-brown, almost black, with red patches; abdomen

red; feet and antennæ black; eyes dark-red; wings broad, rather solid, very dark-brown or nearly black, with a red nervure and two narrow longitudinal hyaline stripes, one of which is between the branches of the nervure. Antennæ of ten subequal joints: the first is tubercular, the next eight are long and compressed in the middle, the tenth is fusiform; all but the first bear many very long hairs, which from the second to the ninth are arranged in rings on the thicker portions of the joints. Feet slender, with many hairs, claw with a single digitule. Eyes prominent, semiglobular, placed on a short cylindrical tubercle; very distinctly facetted, there is a rather large tubercular ocellus close to each eye. The abdomen bears on each side five slender hairy tassels; the anterior ones are moderate, the posterior ones rather long, extending a little beyond the extremity. The haltere is broadly fusiform and large, and bears at the end eight curved setæ, the ends of which are knobbed.

Hab. In Japan, on *Pinus*, sp., Yokohama, in China, on *Ficus*, sp., and on *Gardenia florida*, Hongkong. My specimens were sent by Mr. Koebele.

I have decided, after much consideration, to attach this insect to Westwood's species. I have not seen the actual paper by that author in his "Arcana Entomologica," but Signoret copied the descriptions in his Essai, and from these it appears that Westwood never knew anything but the males of the species which he established. This renders it extremely difficult to identify insects, because, as I observed in 1895 when treating of *Icerya rosæ*, var. *australis*, the males of any given genus differ only very slightly from each other. Westwood established seven species of *Monophlebus* on the males alone, and seems to have given only very brief descriptions of them; from these it appears that he took as his principal characters the colour, the size, and the abdominal tassels. In all the seven, with the exception of one, the wings are black—in *M. raddoni* they are partly red, and I think we may here discard that species. Another, *M. illigeri*, a very small species from Tasmania, may also be put aside, and we have left the following, as described by Westwood:—

M. atripennis, Klug (Java): Thorax black, abdomen red, tassels, five (?) on each side.

M. burmeisteri, Westw. (Java?): Thorax black and red, abdomen red, tassels five on each side.

M. fabricii, Westw. (Sumatra): Thorax black and red, abdomen black, tassels three on each side.

M. leachii, Westw. (Malabar): Thorax black, abdomen red, tassels five on each side.

M. saundersii, Westw. (Southern India): Thorax black and red, abdomen red, tassels four on each side.

Assuming a validity here for colour, *M. fabricii* may be discarded as having the abdomen black. There remains the question, for the others, of the tassels; and here it must be noted that these are exceedingly brittle, so that amongst perhaps twenty specimens hardly five are found with the full number, and the box in which I received mine was littered with fragments of tassels. It is therefore quite possible that the "three" of *M. leachii* and the "four" of *M saundersii* may really be five; indeed, Signoret expresses the opinion that *saundersii* and *burmeisteri* are identical. As for *M. atripennis*, there is a doubt. Westwood's words are not clear. He says, "Abdomine . . incisionibus profundis inter segmenta, appendiculisque duobus carnosis hirtis apicalibus," which may mean two or more tassels- Signoret takes him to mean several. However, I will also discard this species for the present. The three which are left are so similar in colour, in size, and in the tassels that it seems immaterial which we select; but as *M. burmeisteri* has alphabetical precedence it may be well to adopt it, at all events until we know more about them.

The localities set down by Westwood for his species are all in the oriental region, except for *M. illigeri*, Tasmania, and *M. raddoni*, Western Africa. I see no reason why *M. burmeisteri* should not, like so many other Coccids, range over a wide extent, from India to Japan, or further.

It is to be noted that Westwood, following Burmeister, attributes twenty-two joints to the male antenna of *Monophlebus*. This error arose from a failure to observe the compression of the joints, which those authors took for a real division.

Genus ICERYA.

Icerya seychellarum, Westwood. *Dorthezia seychellarum*, Westw.; Gard. Chron, 1855. *Icerya sacchari*, Guérin 1867. *Icerya sacchari*, Sign., Ann. de la Soc. Entom. de France, 1875, p. 352.

I received during the year, from Mr. Koebele, some specimens of a species of *Icerya*, covered with cotton partly white partly pale-yellow. At first this seemed to be new, and perhaps allied to *I. crocea*, Green, a species from Ceylon with yellow cotton; but two of the specimens were so precisely similar to a drawing of *I. sacchari* by M. Poujade, reproduced by Signoret in his pl. xviii., fig. 2, that there was little room for doubt that they belonged to that species. Further examination of the anatomical details, and comparison with specimens of *I. sacchari* sent me in 1882 by Dr. Signoret, satisfied me on the point. Only one character remained uncertain: Signoret says that in the larva the tibia is excessively

short, whereas in my specimens it is of normal length, but possibly he was examining a larva quite recently hatched, whereas mine had been some time alive.

Westwood's specific name has priority, although his determination of the insect as *Dorthezia* is erroneous.

My specimens were collected by Mr. Koebele on *Rosa*, sp., and *Podocarpus*, sp., in China, at Hongkong, Canton, Amoy, and Formosa. The species is therefore by no means confined to the sugar-cane.

Section BRACHYSCELINÆ.

Genus TACHARDIA.

In my paper of 1894 I erroneously attributed this generic name to Signoret. Dr. R. Blanchard, of Paris, informs me that it was he who proposed its substitution for *Carteria* (pre-engaged) in the first volume of his "Treatise on Medical Zoology," and the genus is therefore *Tachardia*, Blanchard.

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III.—BOTANY.

Art. XXIX.—*On the Flora of the North Cape District.*

By T. F. Cheeseman, F.L.S., F.Z.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 5th October, 1896.*]

Plate XXIII.

The extreme north of the Auckland Provincial District, including in that term the North Cape peninsula and the long and narrow strip connecting it with Ahipara and Mangonui, is little known to the residents of Auckland. Nor is this at all surprising. With the exception of one or two runholders, the European population is confined to the diggers of kauri-gum and the storekeepers who supply their wants; there is little or no farming, and practically no permanent settlement. Roads and bridges are unknown, and the usual way of reaching the district is by following the magnificent sandy beach which curves from Ahipara northwards, almost reaching Cape Maria van Diemen. Or the traveller may embark in a diminutive steam-tender that occasionally runs from Mangonui, and which will land him, glad once more to stretch his limbs, either at Ohora or in Parengarenga Harbour. In many respects the district is uninviting. A large portion is more or less covered by drifting sands; another part, almost equally extensive, is occupied with swamps, varied here and there with shallow lakes. There are no forests worthy of the name; the hills are not high enough to be called mountains, and are mostly bare, barren, and desolate-looking. Its sole picturesque features are the cliffs on the northern coast, with their little bays and minor indentations, and the broad western beach, stretching as far as the eye can reach, and lined from end to end with row behind row of white foaming breakers.

The first person to explore the district from a natural-history point of view was the veteran botanist Mr. Colenso, who in 1839 travelled from Kaitaia northwards to Cape Maria van Diemen, and from thence to the Reinga, Spirits Bay, and the North Cape. During the journey he collected several of the plants peculiar to the district, notably *Hibiscus diversi-*

folius and *Lycopodium drummondii*, the last of which has not been refound. In 1840–41 Dr. Dieffenbach, the naturalist to the New Zealand Company, made an exploration of the country to the north of the Bay of Islands. He spent a considerable time in the North Cape peninsula, judging from the account given in his "Travels in New Zealand," where Chapters XII. and XIII. are devoted to the physical features and geology of the district. I cannot learn that he made any botanical collections therein, but the chapters quoted contain several interesting remarks upon the vegetation. In the summer of 1865–66 the district was visited by Sir James Hector, mainly for the purpose of examining its geological structure. This he succeeded in elucidating and mapping,* the results being incorporated in the general geological map of New Zealand first issued in 1869. He was accompanied by Mr. John Buchanan, who made a considerable collection of plants, which I believe was forwarded to Kew. He was the first to detect *Hymenanthera latifolia*, and observed several other species not previously recorded from that part of New Zealand. In April, 1867, Mr. Kirk and the late Mr. Justice Gillies made a brief visit to the district between Parengarenga Harbour and Spirits Bay. Notwithstanding the lateness of the season, a few novelties were collected and much additional information obtained. Some notes on this journey will be found in the "Transactions of the New Zealand Institute" (vol. i., p. 143). A list of the plants observed by Mr. Buchanan and Mr. Kirk is given in vol. ii. of the same publication (pp. 239–246), and a supplementary list by Mr. Kirk appears in vol. iii. (pp. 166–177). So far as I am aware, these three papers comprise all that has been published on the botany of the North Cape peninsula. Its geology, however, was in 1892 again investigated by Mr. A. McKay, the results of his work appearing in the reports of the Geological Survey for 1892–93. I am glad to take this opportunity of expressing my indebtedness to Mr. McKay's paper for much valuable information on the geology and physical features of the district.

My first acquaintance with the northern peninsula was made as far back as 1874, when I visited the shores of Doubtless Bay, the Oruru Valley, Maungataniwha, and a portion of the coast-line between Whangaroa and Mangonui. In 1889 I again called at Mangonui, and also landed for a short time at Cape Maria van Diemen, and in the vicinity of the North Cape. My examination of the Three Kings Islands, made in

* Geological Sketch-map of the Northern District of the Province of Auckland, by James Hector; scale, 4 miles to the inch. Printed by W. C. Wilson, lithographer, Auckland, 1866.

the same year (see Trans. N.Z. Inst., xxiii., pp. 408–424), added several curious and interesting plants to our flora. Not unnaturally, I formed the opinion that most of these would be found on some portion of the North Cape peninsula, for it appeared highly improbable that so small a group, situated little more than thirty-five miles from the mainland, should possess five or six endemic species. Nor were other inducements to visit the district wanting. It had never been carefully examined for plants; several wide-ranging subtropical species, of which *Ipomœa palmata* and *Hibiscus diversifolius* are perhaps the most conspicuous, were known to inhabit it, and both climate and geographical position were favourable to the belief that others might be detected. In short, it appeared to promise a likely field for botanical exploration, and when, at the close of last year, circumstances permitted me to take a brief holiday, it was with no small degree of satisfaction that I left Auckland for the "far north." I was accompanied by my friend Mr. James Adams, head-master of the Thames High School, to whom for active assistance and co-operation I am much indebted. I now propose to present to the Institute an account of the journey, together with a list of the plants observed.

At the outset it will be well to define the district examined, and to give a short sketch of its physical features. For the purposes of this paper, then, I shall consider the North Cape peninsula to consist of the long and narrow tract of country lying to the north of a line drawn from Tokomata Point, about midway between Flat Head and Whangaroa Harbour, to the south side of Tauroa, or Reef Point, the southern extremity of Ahipara Bay. Of course, this is a purely arbitrary line, and is in no sense a natural boundary; but it has the advantage of leaving to the south the high forest-clad plateau between Kaitaia and Whangape, the Maungataniwha Ranges between the Oruru Valley and the Mangamuka branch of the Hokianga River, and the wooded hills to the north of Whangaroa Harbour. In short, it is a line which better than any other cuts off the forests and high land of the country between the Bay of Islands and Mangonui from the open low-lying districts to the north. The extreme length of the district, from Ahipara to Cape Reinga, is about sixty miles. Owing to the irregular and far-reaching indentations of the eastern coast, the breadth varies excessively. From Tokomata to Ahipara is about thirty-five miles; but from the head of Doubtless Bay to the coast north of Ahipara the distance is barely sixteen; while from the Waipapakauri branch of Rangaunu Harbour to the nearest part of the west coast is only four miles and a half. Ohora Harbour and the Waitaia branch of Parengarenga Harbour also reach

within five miles of the opposite coast. North of Parengarenga the district widens, so that from Cape Maria van Diemen to the North Cape is a distance of nearly twenty-five miles. Most of the district is comparatively low-lying. Doubtless Bay is separated from Rangaunu Harbour by a narrow strip raised only a few feet above sea-level; and all round the shores of Rangaunu Harbour and up the valley of the Awanui as far as Kaitaia the country has a very small elevation above the sea. At the head of Ohora Harbour, in many places around Parengarenga Harbour, at the back of Spirits Bay, and at Tom Bowline's Bay are extensive stretches varying from 10ft. to 25ft. above high-water mark. The only hills of any height are those immediately to the north of Mangonui Harbour, which attain a greatest elevation of 1,045ft. Mount Camel, situated on a narrow tongue of land between Ohora Harbour and the sea, reaches 804ft., and in several places along the extreme northern coast the hills vary from 800ft. to 1,000ft. in height.

A slight sketch of the geology will be sufficient, more especially as full particulars can easily be obtained from Mr. McKay's report. The oldest rocks in the district consist of Secondary or Palæozoic strata of somewhat uncertain age, often associated with heavy bands of igneous rocks, mainly syenites and diorites. This formation is well developed near Mangonui, at the southern extremity of Ahipara Bay, at Mount Camel, and at many places along the coast from Cape Maria van Diemen to the North Cape. Cretaceo-tertiary strata, consisting mainly of hydraulic limestones, firestones, shales, and sandstones, occupy the belt between the Oruru River and Awanui, and also occur in several localities around Parengarenga Harbour. Upper Miocene beds, composed of sands and sandy or marly clays, are also developed to the north of Parengarenga. A volcanic breccia of Pliocene age, very similar to the breccia so well developed at the Manukau North Head, is seen at the eastern end of Spirits Bay, from whence it stretches to Tom Bowline's Bay. The whole of the remainder of the district, comprising much the largest portion of its area, is occupied with Recent deposits. These consist of swampy or alluvial deposits, chiefly developed around Rangaunu Harbour and between it and Ahipara, and also occupying a considerable area around Parengarenga Harbour; of ancient sand-dunes, now consolidated and covered with vegetation, and which form the backbone, as it were, of the narrow tract connecting Ahipara with the North Cape peninsula proper; and of sand-dunes of much more recent date, still bare of vegetation, and drifting inland with every gale. These recent sand-dunes are heaped up against the older ones, and occupy a considerable portion of the coast-line,

especially on the western side, where they form a continuous belt stretching from Ahipara to within a short distance of Cape Maria van Diemen. Both the swampy deposits and the consolidated sandhills contain large quantities of kauri gum, which for several years has given employment to a considerable number of gum-diggers.

The arrangement and mode of formation of these Recent deposits show that the northern extremity of New Zealand has been subjected to considerable fluctuations of level since the close of the Tertiary period. Before the formation of the older sand-dunes the greater portion was under water. The high land at the southern side of the entrance to Doubtless Bay was then the North Cape of New Zealand, and from it a shallow sea stretched westwards to Ahipara and northwards beyond the present North Cape. The hills at Cape Karakara, now constituting the north-west side of Doubtless Bay, probably formed one or two little islands in this sea. Further north Mount Camel stood out as another island; while between Parengarenga and the North Cape quite a little archipelago existed. Still further to the north the Three Kings Islands probably reared their higher peaks above water. This period of depression was followed by elevation, and elevation to such an extent that the land stood much above its present level, and probably extended as far as the Three Kings. Magnificent kauri forests covered most of the country, flourishing where now nothing but swamp and lake exist. Then the land sank to somewhere near its present level, and the first line of sandhills was formed—now consolidated and covered with vegetation. Then, after a considerable pause, and possibly after a still further slight subsidence, the younger sandhills came into existence, and the country gradually assumed its present aspect.

The exploration of the district naturally commences at Mangonui Harbour, where the traveller disembarks after his day and a half's voyage from Auckland. It is situated at the south-eastern corner of Doubtless Bay, with which it communicates by a narrow channel barely more than quarter of a mile in width. The township stands on the southern side of this channel, and consists of a narrow street following the sinuosities of the shore. The harbour is perfectly land-locked, and is surrounded by low clay hills devoid of bush, and covered with a stunted growth of *Leptospermum* and *Pteris*.

Many naturalised plants were observed in the township. Immediately after leaving the wharf one's gaze was arrested by large patches of the cardoon (*Cynara cardunculus*) growing 5ft. or 6ft. in height, and forming a mass of prickly vegetation impenetrable to man or beast. The local authorities ought to extirpate it; for, judging from its phenomenal increase in

South America, where whole districts have been overrun with it, its introduction may lead to serious trouble. *Asphodelus fistulosus* was more common than in any other locality known to me. In many places it fringed the roads, and formed clumps on the hillsides above. *Trifolium resupinatum* was in great abundance, and is now found in damp sandy places in most parts of the district. As it produces a fair amount of feed in spring and early summer, its introduction is of decided advantage to the settler. *Apium leptophyllum* was established in several localities. An Australian grass, *Andropogon annulatus*, not previously noticed in New Zealand, was plentiful on a steep slope overlooking the main street. In moist places *Kyllinga monocephala* formed stretches of green grassy foliage 6in. to 9in. high. It was originally discovered by Mr. W. T. Ball, on a swampy flat on the northern side of the harbour, and at the time of my first visit certainly did not occur anywhere on the southern side. It is now in immense abundance, stretching to Kaitaia and Ahipara, and from thence as far as the North Cape. I fear that it must be regarded as an introduced plant, although at the time of its discovery I expressed a different opinion. Many other alien plants of interest were noticed. *Verbena officinalis* was a prominent species, but was not so plentiful as it was twenty years ago, when it covered acres, to the exclusion of almost all other vegetation. *Œnothera stricta*, *Scabiosa atropurpurea*, and *Solanum sodomæum* were all frequently seen, as also many others which it is not necessary to mention in this place.

Crossing to the north side of the harbour, and proceeding towards Tokomata Point, few plants of interest were noticed until the sea-cliffs were reached. Where not covered with bush, these were clothed from base to summit with the magnificent *Ipomœa palmata*, at the time of my visit laden with multitudes of large mauve flowers. It is decidedly one of the most handsome species of our flora, and should be more often seen in cultivation than is the case at present. It succeeds well in gardens in the vicinity of Auckland if a little care is taken at the time of its first establishment. *Calystegia marginata*, which appears to be an extremely local plant in New Zealand, was picked in one or two localities. A few interesting species were noticed in the patches of bush which are scattered here and there along the cliffs, the most noteworthy being *Pittosporum umbellatum* and *P. virgatum*, *Sapota costata*, *Coprosma arborea*, and *Olearia angulata*. On the open hillsides overlooking the cliffs the typical form of *Haloragis tetragyna* was unusually abundant, as also *Orthoceras solandri*, which could be pulled by the handful as the traveller walked along.

The coast-line between Mangonui Harbour and Flat Head

was also explored for a distance of two or three miles. Large masses of the rare fern *Loxsoma cunninghamii* were seen along the banks of the Waitetoki streamlet, and in the light bush covering the hillsides *Pittosporum reflexum* was most abundant. In this locality it showed an unusual amount of variation. In some specimens the leaves were extremely narrow, and the plant could then with difficulty be distinguished from *Cyathodes acerosa*, except by handling it, when the much softer foliage at once betrayed its distinctness. Forms with broader leaves much resembled *Leucopogon fasciculatus*, and those with leaves still wider approached very closely to the typical form of *Pittosporum pimeleoides*.

The Oruaiti River, which discharges into the head of Mangonui Harbour, was examined for some distance. For several miles it is fringed with extensive mangrove swamps, the trees in some cases reaching a height of from 15ft. to 20ft. Along the edge of these swamps is the usual growth of brackish-water plants, such as *Plagianthus divaricatus*, *Crantzia*, *Selliera*, *Samolus*, *Juncus maritimus*, and *Cladium junceum*. Associated with these was an introduced grass, *Polypogon fugax*, now widely distributed through the North Island of New Zealand. The road winds along the margin of the river, in many places fringed with *Asphodelus fistulosus* and *Verbena officinalis*, and with all the plashy places at its side filled with *Kyllinga*. Above the influence of the tide the Oruaiti flows through a broad flat valley, evidently once in cultivation, but now fast reverting to its original vegetation of *Cordyline*, *Phormium*, and *Leptospermum*. *Cyperus buchanani*, Kirk, was extremely plentiful in this portion of its course.

The south-west side of Mangonui Harbour is surrounded by undulating clay hills covered with a scanty vegetation of *Pteris* and *Leptospermum*, mixed with *Pomaderris elliptica* and a few other shrubs. A fine blue *Thelymitra*, probably referable to *T. pulchella*, was very plentiful. At Cooper's Beach, only a short distance from Mangonui, the rare *Todea barbara* grows in some quantity. Some of the clumps were several feet in diameter, and appeared to suffer very little from the fires which sweep periodically over most of the open country in the north. Following the Awanui Road, we skirted the shore of Doubtless Bay, passing a succession of sandy bays separated by rocky headlands adorned with pohutukawas in full bloom. The Oruru River was reached at Taipa, about half a mile above its mouth. Here are extensive sandy flats covered with *Pteris* and an unusually silky variety of *Leptospermum scoparium*. *Isolepis nodosa* was most abundant, and in open places the ground was carpeted with *Zoysia pungens*. Two introduced grasses, *Festuca bro-*

moides and *Aira caryophyllea*, were present in great quantity. Only a small portion of the lower course of the Oruru is included within the limits assigned to this paper, and this is principally covered, where not in cultivation, with *Phormium*, *Cordyline*, *Carpodetus*, and several species of *Coprosma*. *Asplenium umbrosum* was noticed in several places, but on the whole the vegetation possesses few features of interest. Crossing the river at Taipa, we diverged from the Awanui Road in the direction of the head of Doubtless Bay. We passed large quantities of the curious parasite *Cassytha paniculata*—a plant very generally distributed through the open country north of Mangonui. Its twining leafless stems cover the bushes of *Leptospermum* with a close network, binding one plant fast to another, and often ultimately smothering them. After a monotonous tramp of several hours' duration, we descended to the coast near the mouth of the Awapoko River. Here were some sandy flats thickly covered with the introduced *Solanum sodomæum*. Nowhere have I seen it so abundant or so thoroughly at home. The Messrs. Matthews, who own a grazing-run of considerable size in the vicinity, informed me that it is spreading fast, and that a large amount of trouble is required to keep their paddocks moderately free from it. For many years it has been established on the volcanic hills of the Auckland isthmus, but in that locality it has of late shown little tendency to increase its numbers.

On the Awapoko River the long sandy beach commences which forms the head of Doubtless Bay. It is backed by sand-dunes, and behind these a low marshy tract extends as far as the eastern shore of Rangaunu Harbour. On the sandhills the usual arenarian plants appeared, such as *Cassinia leptophylla*, *Coprosma acerosa*, *Pimelea arenaria*, *Muhlenbeckia complexa*, *Phormium*, *Scleranthus*, *Zoysia*, &c. In addition to *Solanum sodomæum*, *Polycarpon tetraphyllum* and *Festuca bromoides* were plentifully naturalised. Immediately behind the sandhills the Awapoko expands into broad brackish-water marshes largely covered with mangroves, and with such plants as *Juncus maritimus*, *Leptocarpus simplex*, *Plagianthus divaricatus*, *Samolus*, *Selliera*, *Crantzia*, *Apium filiforme*, *Ranunculus acaulis*, &c. *Kyllinga* and *Trifolium resupinatum* were the most abundant naturalised plants. Leaving these swamps on our left, we turned our course in the direction of Lake Ohia, a somewhat extensive sheet of water situated about midway between Doubtless Bay and Rangaunu Harbour. It is surrounded by swamps separated here and there by low ridges of firm ground. These ridges run parallel to the shores of Doubtless Bay, and evidently represent lines of old sand-dunes, formed during the period of depression alluded to in the introduction to this paper.

Cladium teretifolium was the predominant plant in the swamps, but mixed with it were *Cladium junceum, Schœnus tenax, S. tendo, Hypolæna lateriflora, Gleichenia dicarpa, Drosera binata, Dianella intermedia*, and several species of *Sphagnum*. *Utricularia novæ-zealandiæ* was plentiful in peaty places, its pretty little lilac flowers at once arresting the glance. The sandy ridges were mainly covered with *Pteris* and *Leptospermum*, mixed with *Epacris pauciflora, Dracophyllum urvilleanum, Pimelea prostrata, Leucopogon fraseri*, and a few sedges and grasses. After a somewhat disagreeable tramp we reached the margin of the lake. We found it extremely shallow, and I was able to wade at least a hundred yards from the shore without overstepping my knees. The bottom was composed of clean white sand almost altogether free from vegetation. I searched in vain for *Isoetes* and *Pilularia*, and the only water-plant seen was *Myriophyllum variæfolium*, which was present in small quantity. It is possible, however, that at a later period of the season, when the water stands at a lower level, the traveller may be more successful in obtaining lacustrine or submerged plants. The surroundings of the lake were dreary in the extreme. On all sides stretched an apparently interminable swamp, with its monotonous growth of sedges. To the south a low range of hills was visible, but so bare, barren, and forbidding that it only added to the desolate appearance of the landscape. Not a tree was visible; and not a sign of life could be seen in the lake itself.

Retracing our steps to the Awapoko, we turned in a south-westerly direction to regain the road to Awanui. After travelling along the flat for about a mile, we ascended the hills which flank its southern side. The resemblance which they present to an old coast-line was most obvious, and it was impossible to avoid coming to the conclusion that we had before us part of the shore of the shallow sea which formerly rolled from Doubtless Bay westwards as far as Ahipara. For the remainder of the day our track led over undulating clay hills covered with a meagre and uninteresting vegetation. No change took place until we reached the Parerau camping-ground, where there is a patch of bush, and a pretty little stream, which in our maps is made to discharge into Lake Ohia, but which really flows into Rangaunu Harbour. The tarairi was the principal tree, but *Carpodetus, Weinmannia, Alectryon, Hedycarya*, and totara were also present. The undergrowth was almost wholly composed of *Coprosma parviflora*, attaining a height of from 15ft. to 20ft. Among the plants gathered was *Erechtites prenanthoides*, not previously seen to the north of the Thames goldfields.

The next morning we were awakened by the song of the

ubiquitous blackbird, now common all through the north. Twenty-five years ago the melodious chimes of the bell-bird would have performed that office for us; but those days have gone, no more to return. Striking camp, we travelled for several hours over clay hills of very similar character to those passed over on the previous afternoon. The only plant of interest gathered was a species of *Utricularia*, which was plentiful in a little *Sphagnum* swamp at the top of one of the hills. It is probably referable to Hooker's *Utricularia colensoi*, although the flowers hardly match his description. At the crossing of the Mangatete River, a stream flowing into the head of Rangaunu Harbour, another patch of forest was passed through. It contained some magnificent puriris and karakas, and the largest specimens of *Dodonæa viscosa* that I have seen. Lower down the valley was the remnant of a small kahikatea forest—probably the most northerly one, for only single trees are found in the North Cape district. Climbing the steep clay hill to the westward of the Mangatete, we reached an extensive table-land, elevated about 300ft. above the sea. For some years it had been a productive gum-field, and the huts of the gum-diggers were scattered plentifully over it. What with their abandoned workings and the blackened results of their attempts to burn off the vegetation there was little for a botanist to investigate, and we pressed rapidly on. Reaching the western edge of the plateau, we descended very abruptly to the Maori settlement of Karepouia. This brought us to the commencement of the Awanui flats, and passing through an almost continuous raupo swamp, with the ditches by the roadside filled with *Epilobium pallidiflorum* and *Sparganium*, we at length arrived at Awanui Township itself.

We had now entered the alluvial plain which stretches from Rangaunu Harbour to Kaitaia, and which is only separated from the western coast by a narrow strip of sandhills. The Awanui River, which enters the plain at Kaitaia, follows a serpentine course through it, finally discharging into Rangaunu Harbour about three miles below the township—that is, in a straight line, for the distance would be trebled if the windings of the river were reckoned. The whole country has a very slight elevation above the sea, and there is a large area of permanent swamp. On the western side, almost at the foot of the sandhills, is a chain of fresh-water lakes of varying size, most of which are little above the level of high-water mark. Apparently the soil is fertile, and probably well suited for cropping. Unfortunately, however, the Awanui is subject to floods, which may take place at any time of the year, and which frequently cover many square miles of the adjacent country, especially if the flood should coincide with the time

of high water in Rangaunu Harbour. From that cause, and from the difficulty of reaching a market, there is little cultivation—probably far less than when Dieffenbach visited the district in 1839. He speaks of extensive stretches of potatoes, of maize "growing 10ft. or 12ft. high," and of "the fields of yellow wheat bowing under the weight of the grain." At that time the plain had a large Maori population, which had to be supplied with food raised on the spot.

Recent heavy rains had raised the level of the water in the swamps of the lower part of the plain, making it impossible to examine their vegetation, as we had intended A cursory glance at the Awanui in the vicinity of the township showed few plants of interest. The banks were fringed with *Cordyline*, *Phormium*, and *Leptospermum*; *Polygonum minus* and *Isachne* were plentiful in most places; and in quiet reaches *Scirpus lacustris* and *Typha* were abundant. *Cyperus buchanani* and *Kyllinga* were of common occurrence, not only by the river, but by the smaller streams and in the ditches by the roadside. About three miles above the township the Awanui is fringed for more than a mile by an extensive kahikatea forest; but this we found impossible to reach except by pulling up the river in a boat, an expedition which would have taken too much time. The approach to Kaitaia, the next stage in our journey, was most attractive after our wanderings on the barren clay hills of Doubtless Bay. Green fields and well-painted houses, the neat church and parsonage, the winding river fringed with willows and poplars, and in the background the forest-clad Takahue Range, together formed a pretty and picturesque scene, well calculated to make the traveller linger on his way. But the time at our disposal was limited, and the district was almost, if not altogether, beyond the limits selected for examination. We therefore passed on in the direction of Ahipara, paying a short visit to Lake Tongonge on the way.

Lake Tongonge is the largest of a chain of lakes situated on the western side of the Awanui River, almost fringing the coast-line of sandhills. It is about three miles in length by perhaps half that width, but is surrounded by a much larger area of raupo swamps, most of which are filled with water during the greater part of the year. After some difficulty we succeeded in finding a practicable track to the margin of the lake; but the absence of a boat and the flooded state of the swamps, prevented us from making a satisfactory examination. I particularly regret not being able to examine the bottom of the lake for *Isoetes* and other submerged plants. The vegetation in the portion of the swamp passed through consisted mainly of *Typha* and *Cladium articulatum*; but *Eleocharis sphacelata*, *Polygonum minus*, *Isachne australis*,

Epilobium pallidiflorum, *Myriophyllum variæfolium*, *Hydrocotyle asiatica*, and *H. novæ-zealandiæ* were all abundant. Near the margin of the lake extensive patches of *Glossostigma* and *Limosella* were observed. I learnt with surprise that large quantities of kauri gum had been obtained from the swamp and from the bed of the lake, the diggers being principally Maoris. In the lake (which is very shallow throughout) it was obtained by diving from canoes; but in the swamp a somewhat curious method was followed. The swamp was first sounded with long gum-spears, quite 15ft. in length, until a large piece of gum was felt. A pointed iron-rod, with 2ft. or 3ft. of its lower end furnished with projecting barbs, was then forced into the swamp and moved about until the barbs became embedded in the gum. Another rod was then fixed in a similar manner to the other side. The rods were then drawn out simultaneously, usually bringing the gum with them. I was informed that the smaller lakes and swamps situated to the north of Tongonge also contain plentiful deposits of gum.

The kauri-tree never grows in low and swampy situations, hence the presence of large quantities of gum in such localities incontestably proves that great changes have taken place in the physical features of the district. When the country between Kaitaia and Rangaunu Harbour was covered with kauri forests the land must have stood at a much higher level, in order to provide free and rapid drainage to the sea. This period of elevation, though recent in a geological sense, is by no means so in the ordinary acceptance of the term, for it was evidently prior to the foundation of the great bulwark of sandhills stretching along the western coast from Ahipara to Cape Maria van Diemen. Even the older and more consolidated sandhills can be seen to overlie the swampy deposits containing gum; and, besides that, they could not have been formed in their present position when the land occupied a much higher level; or, in other words, came into existence only when the period of elevation had passed and the land had sunk to somewhat near its present level.

Proceeding in the direction of Ahipara, the road traverses a stretch of low-lying country mostly covered with tall *Leptospermum*, mixed with *Cordyline* and *Phormium*, and with an occasional undergrowth of *Pteris incisa* and *Hypolepis tenuifolia*. *Veronica elongata* was picked in several places, mixed with such plants as *Epilobium rotundifolium*, *Hypericum japonicum*, *Mentha*, *Callitriche*, &c. The inland form of *Paspalum distichum* was abundant in some half-dry ditches by the roadside. At Waiake we passed some abandoned cultivations completely overrun with dog-roses and sweet-briar, interspersed with clumps of *Albizzia lophantha*.

Senecio scandens was abundant, scrambling over the remnants of the old fences, and many other naturalised plants of interest were catalogued. A little further on is the large native settlement of Pukepoto. Numerous whares stand a little distance from the road, and groups of gaily-dressed men and women were sitting in front of them, idling away the pleasant Sunday afternoon. In a warm and sheltered corner was a large clump of bananas loaded with young fruit. The road now ran close to the foot of the Tamatamahoe Range, the northern termination of the rugged country behind Herekino and Whangape. It has a bold escarpment towards the plains through which we were travelling, and no doubt formed a line of sea-cliffs during the period of subsidence so frequently referred to in this paper. Its summits were covered with forest, amongst which numerous clumps of kauri could be distinguished. This is the northern limit of kauri forests on the west coast, although scattered trees are found as far as the North Cape itself. A few miles further on we passed the remarkable cleft in the range through which the road to Herekino runs. It is a narrow gorge, shut in on both sides with peaked hills of considerable height, which are clothed with forest from base to summit Pressing onwards for a mile or two, we passed through a large Maori settlement, immediately behind which rose the round-topped hill called Puketawatea, on the steep slopes of which were numerous cultivations. Struggling through a patch of drift-sand, we rounded a sharp corner and emerged on the shore of Ahipara Bay.

Before proceeding northwards we made an examination of Reef Point, or Tauroa, the bold headland to the south of Ahipara. It consists of a foundation of igneous rocks, probably of Palæozoic age, capped by recent sandhills, and attains a height of about 700ft. above sea-level. Ascending a gully only a little distance to the west of Reid's hotel, the steep hills on either side of the stream were found to be mainly covered with *Leptospermum scoparium* and *L. ericoides*, which together form at least four-fifths of the vegetation. Other trees noticed were *Dodonæa viscosa*, *Myrsine urvillei*, *Vitex littoralis*, *Myoporum lætum*, *Olearia angulata*, *Brachyglottis*, and *Cordyline australis*. *Cladium sinclairii* and a few other herbaceous plants were common on the rocks by the side of the stream. Little change was noticed until the top of the hill overlooking the gully was gained, when we emerged on a belt of drifting sand, and the usual arenarian plants at once appeared. *Arundo*, *Desmoschœnus*, and *Coprosma acerosa* were particularly abundant. Crossing this, we reached the plateau-like top of the headland. It is composed of old and consolidated sandhills, and supports a scanty vegetation of

Pteris, *Leptospermum*, *Dracophyllum urvilleanum*, *Leucopogon*, *Cassinia*, *Pimelea prostrata*, &c. Broad and shallow gullies were numerous, usually filled with *Cladium teretifolium*, amongst which *Drosera binata* was more than ordinarily abundant. From the trig.-station on the summit we struck southwards to the coast towards Herekino. The only plant of interest noticed during the descent to the beach was *Veronica diosmæfolia*, which occupied the greater portion of a small gully, forming little rounded bushes 4ft. or 5ft. in height. I was informed that twenty years ago it was plentiful in many of the open gullies of the headland, but that of late years it has been largely destroyed by fires and cattle. The tide being favourable, we returned to Ahipara by the beach. All round the headland the hard igneous rocks crop out about high-water mark or a little above it, jutting out seawards to a considerable distance, and thus forming a succession of long reefs. On the top of the igneous rocks are low and rounded consolidated sandhills, which form the coast-line proper. They are mainly covered with *Cassinia*, mixed with *Phormium*, *Arundo*, *Pteris*, and *Leptospermum*. At the base of the sandhills water oozes out freely, forming a narrow belt of moist or swampy ground just above high-water mark. *Selliera*, *Crantzia*, *Scirpus cernuus*, and *Ranunculus acaulis* were plentiful in one or two places, in company with *Myriophyllum pedunculatum*. A little further back *Mazus pumilio* and *Gratiola sexdentata* occurred in profusion, usually mixed with *Mentha cunninghamii*. In wetter places *Glossostigma* and *Lemna minor* were observed. In one or two localities *Hibiscus diversifolius* was noticed, but only in small quantity. It has not been previously recorded from the south of Parengarenga, but it is quite possible that it may be found in other stations on the coast-line towards Herekino and Whangape. Rounding the extreme point of the headland the igneous rocks gradually rose, at last forming low cliffs covered with immense masses of *Cladium sinclairii*, below which *Lobelia*, *Samolus*, and *Scirpus riparius* were most abundant. A few plants of *Ipomæa palmata* were seen, but, generally speaking, the cliffs were much too wet to form a suitable habitat for this fine plant.

I was much interested at seeing in Mr. Reid's garden two young plants of a *Cordyline*, apparently closely allied to the *C. terminalis* of my list of Kermadec Island plants.* On inquiry, I learned that one of the plants, with two others, were found on the hillside almost immediately behind Mr. Reid's house, at an elevation of about 150ft., and not more than a quarter of a mile from the sea. They were growing amongst dwarf *Leptospermum* and *Coprosma*. The second

* Trans. N. Z. Inst., xx., 174.

plant was obtained near the Harihaia Stream, which discharges into Ahipara Bay about half a mile to the west of Mr. Reid's house. Since the discovery the coast has been searched for a considerable distance, but no additional plants have been seen. Miss Reid, who found all the specimens, kindly showed me the exact localities, but with the closest scrutiny I failed to find any further trace of the plant. Mr. Kirk, in the recently-issued volume of Transactions, has paid me the compliment of suggesting the name of *Cordyline cheesemanii* for it. It is possible that he may be right in considering it to be distinct; but its affinity to *C. terminalis* is evidently very close, and in the absence of flowers and fruit I should be inclined to place it with that species. It is worth remarking that both the localities where the plants were found have been at one time cultivated by the Maoris.

The next morning we started for the extreme north. Our road was the magnificent sandy beach which stretches without a break from Ahipara to the rocky coast near Cape Maria van Diemen, a distance of over fifty miles. Smooth and even from end to end, and beaten firm and hard by the daily wash of the tide, it puts to shame the most perfect productions of Macadam. On our left was the open ocean, with the everlasting roll and roar of its waves on the shore; to our right mile after mile of low rounded sandhills, bare of vegetation, and drifting inland with every gale. For fully two miles after leaving Ahipara the sandhills were covered with Maori kitchen-middens and shell-heaps, an indubitable proof of the former existence of a large population. Most of them disappeared when we reached Waimimia, the outlet of the Wairoa Stream. Here was a large brackish-water lagoon, devoid of vegetation except a few patches of *Ruppia*. Crossing the stream, the rising tide compelled us to walk at the very base of the sandhills, which for miles were fringed with *Spinifex* and *Desmoschœnus*. In moist places near high-water mark such plants as *Selliera*, *Samolus*, *Crantzia*, *Leptocarpus*, and *Paspalum distichum* were occasionally seen. Further away from the sea the sandhills were generally bare; but here and there small areas were covered with *Cassinia leptophylla*, *Coprosma acerosa*, *Muhlenbeckia complexa*, *Arundo*, and other arenarian plants. For many miles—quite fifteen, indeed—no change was noticed, and the sameness in the coast-line became distressingly monotonous. At length we reached a place known as Waihi, where some beds of lignite crop out a short distance from the beach, forming bluffs 10ft. or 12ft. in height. They are capped by sandhills, and everywhere at the junction of the sand and lignite water oozes out, trickling down the face of the cliff and forming a narrow

swamp at its base. I found this an excellent collecting-ground, and a couple of hours were profitably spent in examining it. Large tufts of *Lomaria banksii* were common on the wet lignite, mixed with such plants as *Plantago raoulii*, *Lobelia*, *Samolus*, *Apium australe*, *Fuchsia procumbens*, and a curious variety of *Cotula minor*. In the strips of swamp were *Typha*, *Cladium articulatum*, *Leptocarpus*, *Myriophyllum variæfolium*, *Mazus*, *Glossostigma*, and *Epilobium chionanthum*. I also observed a few tufts of *Nephrodium unitum*, one of those tropical ferns which in New Zealand are found almost solely in soil heated by hot springs. It was first noticed in the "far north" by Mr. J. B. Simpson, who as far back as 1886 sent me specimens gathered in a swamp near Ohora. Resuming our journey, the monotonous line of sand-dunes again appeared, and continued until we reached Hukatere, about twenty-five miles from Ahipara, where we camped for the night.

Early the next morning we left for Ohora, on the eastern coast For the first two or three miles the track, if such it can be called, led us over moving sandhills as near as possible free from vegetation. On our right was Hukatere Hill, a dome-shaped elevation perhaps 250ft. high, covered with *Cassinia*, *Leptospermum*, and *Pteris*. To the left white rolling sandhills stretched as far as we could see. The chief plants by our line of march were *Desmoschœnus*, *Leptocarpus*, *Arundo*, *Coprosma acerosa*, and *Muhlenbeckia complexa*. It was curious to see huge tussocks of *Leptocarpus* elevated upon pillars as thick as a man's waist, and 4ft. and 5ft. high, altogether formed of the compacted roots and rhizomes of the plant. We passed a few small lagoons, round the margin of which were great quantities of *Limosella* and *Glossostigma*, accompanied by a curious *Eleocharis*, probably identical with *E. neozealandica*, Clarke. Shortly after, we reached the consolidated sands which separate the moving dunes of the west coast from those of the east. They proved to be barren and dreary in the extreme Stunted tea-tree and fern on the hills and *Cladium teretifolium* in the broad swampy gullies formed the chief vegetation. *Cassytha* was everywhere parasitic on the tea-tree, its interlaced and trailing branches constantly catching the feet of the traveller if he attempted to leave the path. In a large wet swamp I gathered *Scirpus fluitans*, not previously seen to the north of the middle Waikato basin. We arrived at Ohora soon after mid-day; a violent thunderstorm, with the most vivid lightning, accompanied by heavy rain, driving us into a gum-shed for the rest of the day.

Ohora Harbour is a long and narrow inlet situated half-way between Mangonui and Parengarenga. The entrance is little more than a quarter of a mile in width, and almost in the

middle of the narrowest part a tall and picturesque rock called Tokoroa juts out, closely resembling the Arrow rock in the entrance to Nelson Harbour. The southern head is low and sandy, presenting a very uninviting appearance; the opposite shore is formed by Mount Camel, which rises abruptly from the water's edge to a height of 800ft. Once past the entrance, the harbour rapidly widens, but it also becomes very shallow, and at low-water is little more than an expanse of mud-banks separated by narrow and tortuous channels.

The vegetation on the south side of the harbour is uninteresting, and calls for few remarks. Near Mr. Subritzky's residence *Melianthus major* was naturalised in some quantity, accompanied by *Vinca minor*, *Iris germanica*, *Asphodelus fistulosus*, and other garden escapes. On the northern side a narrow strip of fertile land, often little more than a few yards in width, intervenes between the shore and the steep slopes of Mount Camel. At no distant date it has been almost wholly occupied by Maori cultivations, and the sites of their dwellings and hangis could still be distinctly traced. It was dotted over with the remnants of former groves of karaka-trees, probably planted for the sake of the edible fruit. Peach-trees were plentiful; and on all sides one saw such plants of foreign origin as *Albizzia lophantha*, *Lycium*, *Physalis*, &c. Behind this little flat the steep face of the mountain was scored with short gullies, some of them with small patches of bush and tiny rills of water. The principal tree was the pohutukawa, but *Vitex*, *Dysoxylum*, *Brachyglottis*, *Entelea*, *Coprosma robusta*, *C. grandifolia*, and *Piper excelsum* were all abundant. The rare *Colensoa* was detected in one or two sheltered nooks, but was by no means plentiful. *Rhabdothamnus* was unusually abundant, forming the greater portion of the undergrowth; and in the more precipitous places the rocks were covered with immense masses of *Arthropodium cirrhatum*. Unusually large quantities of *Nephrodium velutinum* were observed. We made no attempt to ascend the mountain, as the whole of the upper portion had been burned off a few days before our arrival. Proceeding along the coast in the direction of Cape Perpendicular, the principal tree was still the pohutukawa, but mixed with it were numerous fine specimens of *Sapota costata*, some of them of unusual size. The slopes of the hills were mainly covered with *Brachyglottis* and *Olearia furfuracea*. Near the beach *Fuchsia procumbens*, *Colensoa*, and *Pteris comans* were not uncommon. Cape Perpendicular was bare of forest, and its sides were scored with numerous shoots or slides of rocky *débris* which had rolled from the hills above. *Coprosma baueriana*, *Rhagodia*, *Apium australe*, *Samolus*, *Mesembryanthemum*, and other well-known coast plants were observed. Near Stanley Point a few specimens of *Hymenanthera latifolia*

were noticed, but apparently it is far from common in this locality.

Leaving the coast, we crossed to the track leading to the head of Ohora Harbour. *Veronica diosmæfolia* was observed in a small gully which flows into the harbour from the north-west side of Mount Camel, but only in small quantity. Our road now led over open kauri-gum land with the usual sparse vegetation of *Leptospermum, Pteris, Dracophyllum urvilleanum, Epacris pauciflora*, &c. Many of the gullies contained large clumps of *Todea barbara*, its erect rigid habit and massive mode of growth making it easy of recognition from a considerable distance. It was often associated with *Gleichenia flabellata*, to which it offered a most striking contrast. We reached the Waihopo Stream, at the head of Ohora Harbour, a little before dusk, and camped near Mr. Tynan's gum-store.

The Waihopo, which is a stream of considerable size, in the lower portion of its course flows through an extensive raupo swamp, which we had not time to visit. Near our camping-ground it was fringed with *Cladium* and *Eleocharis*, amongst which the New Zealand form of *Nephrodium thelypteris* was not uncommon. Large masses of *Myriophyllum variæfolium* choked the bed of the stream, and *Glossostigma* was plentiful on the muddy banks. Further on, the banks of the stream became higher, and were covered with *Leptospermum* and occasional bushes of *Coprosma cunninghamii*. In a warm and sunny corner some distance back from the stream *Melianthus major* was abundantly naturalised. The road to Parengarenga, on which we were now travelling, follows the course of the Waihopo for two or three miles. For the whole of this distance, and as far beyond as we could see up the valley, the stream was fringed with thickets of an Australian *Acacia* with lanceolate phyllodia. In many places both sides of the stream were entirely blocked with it, and single plants were thickly scattered on the slopes of the hills flanking the valley. It is evidently spreading fast, but I was unable to gather any particulars as to the mode of its introduction. Leaving the Waihopo, the road traverses a dreary stretch of kauri-gum land, with the usual vegetation of *Pteris* and *Leptospermum*. For several miles the only plant of interest noticed was *Spiranthes australis*, which was abundant in one little swamp, specimens fully 2ft. in height being collected. The flowers vary in colour from dark-rose through pink to white. With the exception of a solitary locality on the Great Barrier Island, it had not been previously observed to the north of the Auckland isthmus. At noon we reached the Maori settlement of Te Kao, situated near the head of a little stream flowing into the southern branch of Parengarenga Harbour. The settlement consists of about twenty whares, a meeting-house,

native school, and schoolmaster's house. There is some fairly good land by the side of the stream, the Maoris cultivating kumaras, maize, potatoes, and melons. *Chenopodium ambrosioides* was plentiful about the whares, and *Hibiscus trionum* was noticed growing as a weed in the cultivations. At Te Kao the geological structure of the country changed. We had left behind the consolidated sands, and had entered upon a volcanic conglomerate of Middle Tertiary age. The soil was red and friable, and loaded with pebbles of ironstone; and, although by no means fertile, was not so excessively barren as that over which we had travelled during the morning. After leaving the settlement the road became much more hilly. On our right we passed several lakes, some of which were examined for water-plants, but without finding anything of special importance. To the left the gullies contained small patches of bush, mainly composed of puriri, *Knightia*, *Dysoxylum*, *Corynocarpus*, *Cordyline*, *Cyathea medullaris*, and *C. dealbata*. Crossing a tongue of the drifting sands from the western coast, the road followed the watershed between two of the main branches of Parengarenga Harbour, passing over open "gum" country with a very monotonous vegetation. *Pomaderris edgerleyi* was of common occurrence, but hardly any other plant of importance was noticed. Mr. Yates's station at Te Paua, on the shore of Parengarenga Harbour, was reached a little before dark.

Parengarenga Harbour is a large and, in many respects, a remarkable inlet. The entrance is narrow, being barely more than half a mile in width. The northern head is formed by a bold bluff of volcanic conglomerate; the south head is a spit of dazzling white sand, which stretches away for miles, forming the shore of what is called Great Exhibition Bay. When the entrance is fairly passed the harbour spreads on all sides like the fingers of an outstretched hand. One broad arm runs due southwards in the direction of Te Kao, and is only separated from the sea by the spit of sand just mentioned. Another takes a northern course, reaching within two miles of Spirits Bay. Two more run respectively west and north-west, both of them penetrating to within a short distance of the western coast. All the branches are shallow; and at low water a great portion of the harbour is laid bare in the shape of extensive mud-flats. The adjacent country is composed of low undulating clay hills. It is quite bare of forest, and the vegetation is nowhere luxuriant; in most places it could be correctly described as sparse and scanty. The geological structure is interesting, mainly on account of the great variety of formations represented in a comparatively small area. It would take up too much space to describe it in detail here; nor is this necessary, seeing that full particulars are given in

Mr. McKay's report. A passing allusion may be made to one feature, especially as it is sure to attract the notice of all visitors. In many places along the shores of the harbour, and particularly at the junction of the various branches, are extensive flats, elevated from 10ft. to 15ft. above high-water mark, and composed of estuarine deposits. They contain numerous fossils of species still living in the locality, and are covered with a thin stratum of peaty soil, in which kauri gum and the remains of kauri-trees are embedded. The size and number of these flats, their even surface, and the fact that in all parts of the harbour they maintain the same height above high-water mark render them a very conspicuous feature. Their significance is obvious: they prove the existence of a period of depression, followed by one of considerable elevation.

We remained a day and a half at Te Paua, waiting the arrival of the little steamer "Staffa" with a further supply of drying-paper. During this time short excursions were made to several points on the shore of the harbour. The most noteworthy plant collected was *Drosera pygmæa*, which was plentiful on the low peaty flat stretching from Te Paua towards the entrance of the harbour. It was first collected by Mr. Colenso in 1839, "in marshes near Cape Maria van Diemen," according to the Handbook; but Mr. Colenso informs me that he fancies his specimens were really obtained near Ahipara. It was not seen again until 1877, when Mr. Kirk collected it on the Bluff Hill, in Southland. These two stations, at the two extremes of the colony, have been the only ones recorded until now. Its distribution appears to be most anomalous; but it is so easily overlooked that it may be expected to occur in intermediate localities.

Having obtained our drying-paper, we left Te Paua about noon, intending to ford the Ngatikorangi branch of the harbour and then proceed by way of Te Paki Station to Cape Maria van Diemen. On reaching the ford, however, we found the tide too high to admit of our pack-horse crossing without endangering the collections, and we consequently turned to the south-west, intending to head the creek and then proceed direct to the western coast. After travelling for some hours over open kauri-gum land, we crossed a stream called Whakatiriohau, chiefly remarkable for the immense masses of *Gleichenia flabellata* growing along its sides. Passing over some hills largely covered with *Pomaderris edgerleyi* and *Epacris pauciflora*, we at length reached the Ngatikorangi near its source. Here the consolidated sandhills contained numerous funnel-shaped holes from 12ft. to 15ft. in depth, their sides covered with a profusion of *Gleichenia flabellata*, *Todea barbara*, and *Doodia media*. Proceeding a mile or two

further, we camped for the night in a little hollow near the edge of the drifting sands.

Our camp was within a short distance of a celebrated pohutukawa-tree widely known to the northern Maoris by the special name of Kahika. It has an enormous crown of spreading branches, which are buried in sand almost to their tops, no part whatever of the trunk being visible. Notwithstanding the immense amount of sand which must be piled around it, the tree has every appearance of health and vigour. According to the Maoris, it is of great antiquity, and has for generations been used to mark the boundary of the lands belonging to a particular hapu. It is evidently the tree mentioned by Dieffenbach in his "Travels in New Zealand" (vol. i., p. 201), although he erroneously calls it a puriri. Probably he was never actually close to it. As it stands on the eastern slope of the sandhills it is a conspicuous object from most parts of Parengarenga Harbour, and Captain Drury, in the "New Zealand Pilot," uses it for one of the leading marks for entering the harbour.

The next morning we crossed the drifting sandhills to the coast, the greater portion of our road being down a broad sandy valley called Kanaparana. On either side were tall sandhills absolutely bare of vegetation, but in the moist sand near the stream some interesting plants were observed, such as *Eleocharis neo-zealandica, Myriophyllum pedunculatum, Gunnera arenaria*, &c. From the mouth of the stream a walk of three miles brought us to the bold rocky bluff called Pukekarea, locally known as Scott's Point. This is the northern end of the sandy beach, which, commencing at Ahipara, runs thus far—a distance of over fifty miles—without a single break. The vegetation on the cliffs proved most disappointing. It consisted mainly of *Arundo, Phormium, Cassinia, Arthropodium, Apium*, and *Mesembryanthemum. Coprosma baueriana* was present in small quantity; and in one little bay I observed a few plants of *Hymenanthera latifolia. Panax lessonii* and *Fuchsia procumbens* were plentiful in a small gully. On a sandy flat at the foot of the cliff, evidently often used as a camping-ground, *Polypogon monspeliensis* was abundantly naturalised. A curious *Nertera*, probably undescribed, was common in grassy places. Finding it impossible to make our way any further by the beach, we ascended to the top of the bluff, which formed a broad plateau with an elevation of from 400ft. to 500ft. A more dreary place can hardly be imagined. Exposed to the full force of the westerly gales, the wind-swept soil was in many places entirely bare of vegetation. Usually, however, it was covered with a dwarf growth of tea-tree, mixed here and there with *Cyathodes* and *Leucopogon.* At the very edge of the cliffs were large patches of *Zoysia,*

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Selliera, Samolus, Leptocarpus, and other plants that delight in salt-sea spray. In one sheltered little bight a patch of *Veronica speciosa* was observed—really the only plant of special interest seen in the locality. Descending into a sandy bay on the northern side of the bluff, we passed a moist bank covered with *Gunnera arenaria* loaded with ripe fruit. From the abundance of the yellowish-red fleshy spikes it presented quite an ornamental appearance. Further on the slopes leading down to the bay were clothed with *Phormium,* or with a coppice growth of pohutukawa 6ft. to 15ft. in height, the stems growing quite close to one another like tea-tree. Reaching a long low point called Pitokuku, we struck inland over some sandhills to a sheltered camping-ground close to a little tributary of the Werahi Stream.

Half an hour's walk on the following morning brought us to Cape Maria van Diemen, the extreme north-west point of the colony. The cape itself consists of a small island about 250ft. in height, separated from the mainland by a passage perhaps three-quarters of a mile in width. About fifty species of plants, native and introduced, were catalogued on the island. *Phormium* was the most abundant plant, but *Cassinia, Muhlenbeckia complexa, Mesembryanthemum, Arundo, Scirpus nodosus,* and other common seaside plants were plentiful. Under the flax-bushes the rare land-shell *Bulimus bovinus* can be obtained in some numbers, although it has decreased considerably since pigs and goats were introduced. Originally it must have existed in immense numbers, for the landward slope of the island is covered with the dead and bleached shells. Immediately opposite to the island, and bearing south-east from it, is a high rocky hill quite 400ft. in height, joined to the mainland by a low strip of drifting sandhills. It is bare and desolate-looking, and has little vegetation on its landward face, except scattered plants of *Cassinia, Leptospermum, Scirpus nodosus,* &c. The cliffs towards the sea are still more barren. Here and there *Coprosma baueriana* may be seen, flattened and appressed to the rock; in other places are some straggling pohutukawas, shorn by the wind until their branches barely exceed a foot in height. In crevices of the rock the typical form of *Asplenium obtusatum* was not uncommon, accompanied by *Lobelia, Samolus, Triticum multiflorum,* &c. *Desmoschœnus, Spinifex, Festuca littoralis,* and *Convolvulus soldanella* were the commonest plants on the sand. On the whole, the neighbourhood of Cape Maria van Diemen cannot be said to be attractive. Bare and barren rocks, flanked by high rounded sandhills, make up the dreary landscape; while seawards there are the miles and miles of savage breakers on the Columbia Reef, and nearer at hand the incessant roar of the waves on the shore.

Travelling eastwards, we soon reached the mouth of the Werahi, a stream of considerable size. A small Maori village once stood there, mentioned by Dieffenbach and other early travellers, but it has been abandoned for very many years, and a line of kitchen-middens and shell-heaps alone remains to mark its site. Crossing the stream, we proceeded along a sandy bay for a few miles, at length reaching a steep and jagged bluff, which effectually prevented all further progress on the beach. Turning up a little gully, we gradually gained the top of the steep range which now ran parallel with the coast. Following the ridge for a short distance, we soon arrived at the top of the hill overlooking the Reinga, so well known in Maori tradition.

Most of us are aware that the Maoris believed that immediately after death the soul made its way to the extreme north of the country and descended into its future abode beneath the earth at a place called Reinga. So implicit was their belief in this tradition that they asserted it was quite possible to hear at night the sounds made by the spirits passing through the air on their northward journey, and that this was especially the case after a great battle, when multitudes were slain. In such instances they became aware of the event long before the news could reach them by ordinary means. Persons who had been so seriously unwell that their lives were despaired of, but who recovered, were said to have been at the brink of the Reinga, but to have returned. They even had traditions of people who had died, and descended the Reinga, but who nevertheless returned to earth and life and related what they had seen. A belief so widespread and so generally accepted invested the locality with a particular sanctity in the eyes of a Maori, and hence in the early days of the colony the visits of Europeans were regarded with dislike. So far as I can ascertain, the first European who actually reached the Reinga was the Rev. W. G. Puckey, who journeyed thither from Kaitaia in 1834. An account of his visit is given in the "Missionary Register" for 1835. In 1839 the Rev. Mr. Matthews and Mr. W. R. Wade followed in his footsteps. An interesting notice of their journey is also given in the "Missionary Register," and, as that publication is not now generally accessible, I will give a few extracts from it. "It became dark before we reached the village adjacent to the Reinga (Werahi). At first we could not find a single individual in the place, till we discovered three men crouched in a dark corner. We shook hands with two of them; the third was Wareware, a chief of some importance, and father of Te Morenga. On Mr. Matthews holding out his hand the old man drew back with a peculiar growl of displeasure, demanding what business we had there, telling us

we had better be off, and adding, 'Spear me! kill me!' meaning that if we did so it would scarcely be a greater offence. This is the last village at this extremity of the island, and the only one, except Kahokawa, within many miles of the Reinga, the fabled departing-place of the New-Zealanders." On the next morning, "leaving two of our lads in charge of the tents, about 8 a.m. we commenced our journey to the Reinga. After the first ascent the road ran along the very edge of a tremendous rocky precipice; and in one sharp ascent the grass was so slippery that it was difficult to keep one's feet. The descent to the rocks of the Reinga was rather better than the ascent. This brought us down to a little rill of water, called Wairatane, or Waioterata. The *kehuas*, or spirits, travel, it is said, along the road which we had passed. At one place, near Kahokawa, they stop for a parting look and a long farewell to the land of their fathers. Other spots on the road are marked by *wakaaus*, or tokens, to denote the resting-places of the wearied spirits. These are little bundles of rush tied in a loose knot; a green bundle, of course, indicating a recent death, as each spirit, in passing, leaves his *wakaau*. On arriving at the Wairatane, some *kehuas* make a stop there, and then return. An old spirit stands waiting at the opposite side of the river with a stick or plank in his hand, which, on the arrival of a new-comer, he appears to lay down as a bridge. Sometimes his offer is rejected. 'No,' says the newly-arrived, 'I mean to go back again.' The case meant by this emblem is that of a native who has been, as we say, at death's door, and has recovered. Sometimes the friends of the individual who has so recovered ask him, 'No hea koe?' (whence have you come?) He replies, 'No te Waioterata' (from the Waioterata). But once past the stream there is no return from the dreary region beyond. The opposite is, with them, the bourne from which no traveller returns. From the Wairatane the spirits of the deceased glide along the rocks till they come to a perforated rock, where, passing through a small hole, they then ascend to the peaks of those projecting rocks to which more properly belongs the name of Reinga—wild rocks running out to sea. From peak to peak the spirits again descend—where none but spirits could—till they arrive at the projecting branch of a pohutukawa-tree (*Metrosideros tomentosa*). Why this is called the Aka of the Reinga I could not ascertain. On this branch the spirits hang for a while, taking their final earthly rest. The branch is bent downwards in consequence, it is said, of the number killed in Hongi's wars, whose spirits crowded together upon it. Thence they drop on to the flat rocks below, and pass out to the extreme point—which might fairly be called 'the land's end'—there plunging into the deep. A

hole beneath the mass of floating seaweed, the entrance to the unseen world, finally receives them."

We had no difficulty in identifying the chief features of the locality as described in the preceding narrative. Descending the hill, in all probability by the same track as that followed by Mr. Matthews and Mr. Wade, at its very foot we encountered a tiny rivulet of water—a mere trickle—evidently the Waioterata of Maori story. It was fringed with *Phormium* and *Cassinia*, accompanied with *Cyperus ustulatus*, *Scirpus nodosus*, *Pratia angulata*, *Mentha*, and other common plants. The stream evidently drains from a little hollow on the face of the hill, in which was a group of small pohutukawa-trees. Crossing the stream we stood at the foot of the Reinga itself. It is simply a rocky headland about a quarter of a mile long, of no great width, jutting out into the sea in an almost due north direction. At the part next the mainland, which may be called the "neck" of the point, it is quite low, certainly not exceeding 50ft. in height, and is partly swept over by drift-sand from the westward. It then rises abruptly, forming a steep round-topped boss of rock perhaps 250ft. high. On the further side of this it sinks quite as suddenly, passing into a narrow knife-edged ridge beset with sharp points and pinnacles of rock, over which it seemed impossible for either man or beast to pass. It then again rises and drops, finally rising a third time to form a rocky rugged mass about 150ft. in height, which sinks precipitously into the rocky beach below. Seen from the westward, the outline of the headland thus presents three prominences of gradually-decreasing height, separated by much lower portions. The Reinga is surrounded by a broad shelving beach of solid rock, and as it was low water at the time of our visit we were able to walk round it. The western side is almost entirely bare, except on the upper part of the first prominence, which has a good deal of *Phormium*, *Arundo*, *Cassinia*, *Leptocarpus*, *Senecio lautus*, *Lobelia*, *Sonchus*, and other maritime plants. On the eastern side there is rather more vegetation. The pohutukawa or "aka" of the Reinga, so famous in Maori story, still exists, although bearing the marks of extreme age, and evidently only a fragment of what it once was. The overhanging branch, from which the spirits of the Maoris were said to drop on to the beach below, had long ago been broken off—probably by some storm—and only its whitened stump remains. The tree stands about 50ft. above the level of the beach, and is placed rather more than two-thirds of the length of the headland from the shore. A second pohutukawa of smaller size grows a little distance higher up than the first, and a few plants of *Coprosma baueriana* and some patches of *Mesembryanthemum* may be

seen in close vicinity. We looked in vain for the floating mass of seaweed which was supposed to protect the entrance to Hades; but possibly the sea was too rough or the tide not low enough for us to observe it.

To the eastward of the Reinga the coast is high, rocky, and precipitous. In many places the sea beats full against the foot of the cliffs, so that further progress along the beach became quite impossible. Travelling along the top of the cliffs for about two miles, we reached a sheltered little inlet called Otongawhiti. A pretty little stream runs into it, its banks fringed with pohutukawas, amongst which we noticed a few handsome and well-grown specimens of *Sapota*. *Entelea*, *Hoheria*, and *Myrsine urvillei* were plentiful, and *Coprosma rhamnoides* and *Rhabdothamnus* formed dense thickets by the side of the stream. At the head of the little valley were numerous specimens of *Veronica diosmæfolia*, varying from 12ft. to 15ft. in height, some even reaching 20ft. The slender trunk was about the thickness of a man's wrist, and was bare almost to the very top, where it suddenly expanded into a broad and dense round head. The whole appearance of the plant was so very different from the usual form of the species, which is a closely-branched bush 2ft. to 4ft. high, that at first I took it for *Veronica parviflora*, a large form of which it much resembled. It was only by breaking down a specimen and obtaining flowers and fruit that I satisfied myself of its true nature.

A short walk over very uninteresting country brought us to Tapotopoto Bay, one of the most picturesque indentations on the northern coast. Its sides are formed by steep rocky cliffs, which, near the entrance, reach a considerable height. At the head is a narrow strip of sandy beach, perhaps half a mile in length, backed by a miniature belt of sand-dunes, with the usual covering of *Cassinia* and *Phormium*. Further back still the bay is shut in by a semicircular range of hills, most of which has been cleared and grassed, although in many places the indigenous vegetation is again asserting itself. A little sandy flat near the sea has at one time been planted with buffalo-grass (*Stenotaphrum*), which still holds its own, and has even pushed colonies up the sides of the hills. A stream of considerable size enters the bay at its eastern side. At its mouth it forms a brackish-water inlet, covered with mangroves, *Plagianthus divaricatus*, *Juncus maritimus*, *Dichelachne stipoides*, and other well-known littoral plants. A little distance up the valley the stream forks, and near the junction is a little patch of bush containing some fine tree-ferns (*Cyathea medullaris*). The principal trees noticed were *Vitex*, *Tetranthera*, *Eugenia*, *Dodonæa*, *Melicytus ramiflorus*, and *Hoheria populnea*. The last mentioned appears to be abundant in the northern

peninsula in the patches of forest. The undergrowth was largely composed of supplejack (*Rhipogonum*), *Pteris macilenta*, and *Polypodium pennigerum*.

Crossing the stream, we ascended a ridge leading to the summit of Tirikawa, or Darkins's Hill. This reaches an elevation of 1,010ft., and is the highest hill in the North Cape peninsula. It is situated close to the coast, its northern slopes plunging almost precipitously into the sea. Most of its southern side is covered with light bush, forming one of the largest tracts of forest in the peninsula. Near the summit, which must be completely exposed to the full force of the westerly winds, the vegetation is principally composed of stunted *Brachyglottis*, mixed with *Phormium*, *Coprosma rhamnoides*, *Ozothamnus glomeratus*, and *Rhabdothamnus*, the latter a somewhat unlikely plant to occur in such an exposed locality. *Myrsine urvillei*, *Leucopogon fasciculatus*, and *Cordyline australis* were also noticed. Lower down the hill a few kauris were seen, but poor, dwarfed, and stunted compared with those forming the magnificent kauri forests of Kaipara and Hokianga. Two or three small totaras were also noticed. Nikau-palms were plentiful, but all much under the average size. A few ratas were scattered here and there on the side of the hill, their round massive tops, covered with flaming bunches of flowers, rendering them conspicuous from afar. The most abundant tree was *Leptospermum ericoides*, but tarairi, kohekohe, mangeao, *Schefflera*, *Pittosporum tenuifolium*, *Panax crassifolium*, and *P. lessonii* were all plentiful. The undergrowth was largely composed of *Freycinetia*, *Astelia trinervia*, and several species of *Coprosma*. A large much-branched form of *Dracophyllum squarrosum* was collected, but was apparently far from common. On the seaward side the slopes were mostly open and grassy, but here and there were patches of pohutukawa and *Sapota*, while *Olearia angulata* was plentiful.

Between Tirikawa and Whangakea, near the western end of Spirits Bay, the country is composed of low steep hills separated by narrow gullies, many of which contain patches of forest. Kauri and rimu were occasionally seen, but the major portion of the bush was composed of *Leptospermum*, mixed with *Vitex* and *Nesodaphne tarairi*. In swampy places *Eugenia* was plentiful. Descending to the sea, near the mouth of the Whakapoko stream *Ipomæa palmata* was observed in great abundance on the cliffs. An undescribed *Coprosma*, with curious verticillate leaves, was also gathered. It was originally found near Tapotopoto by Mr. T. Kirk many years ago, and I have much pleasure in associating his name with it. Passing Whangakea, where there is a fertile valley partly occupied with

Maori cultivations, a walk of barely a mile brought us to Spirits Bay.

Spirits Bay is at least eight miles in breadth. It is backed from end to end by a ridge of low sandhills, in many places bare of vegetation, in others covered with a scanty growth of *Spinifex*, *Desmoschænus*, *Coprosma acerosa*, *Muhlenbeckia complexa*, and other common arenarian plants. Here and there the loose sand on the crest of the ridge has been blown inland, exposing a much older surface of hardened and consolidated sands. Over this, numerous remains of Maori occupancy are scattered—lines of shell-heaps and old cooking-places, human bones, and a few moa-bones. Most of the latter were very fragile, and but few perfect specimens were collected. Immediately behind the sandhills is a belt of marshy ground of varying width; behind that are low undulating clay hills, mainly covered with short tea-tree and fern, and presenting a dreary and barren appearance. Further back still lies a tall conical hill called Rangitane, the summit of which is crowned by the remains of a large Maori pa. At the western end of the bay is a stream of considerable size—the Waitahoro—but its mouth is almost always closed by a barrier of sand. An extensive lagoon is consequently formed, which is entered by the sea at spring-tides and during storms. *Zostera* is plentiful in the lower portion of this, and nigher up *Ruppia* is equally abundant. Fringing the lagoon are wide sandy or muddy flats, most of which are evidently overflowed at high spring-tides. *Mimulus repens* was common over almost the whole of this area, accompanied with such species as *Selliera*, *Samolus*, *Chenopodium glaucum*, *Cladium junceum*, *Juncus maritimus*, &c. *Cladium articulatum* and *Polygonum minus* were the most prominent species in the swamps at the back of the sandhills.

The eastern side of Spirits Bay is much more picturesque. A little stream, the Kapowairua, enters the sea at the very end of the bay. On one side are Maori cultivations—neat and well-tended patches of kumaras and potatoes. On the other rises a steep pinnacle of basaltic conglomerate, a perfect sugar-loaf in shape, perhaps 500ft. in height. At its base is a pretty little grove of karakas, mixed with a few pohutukawas. The sides and summit are practically a mass of solid rock, in the crevices of which occasional plants of *Phormium* and *Arthropodium* maintain a precarious existence. Further to the northwards is Hooper's Point, a low, rounded headland mainly covered with *Arundo* and *Phormium*.

In a little swamp close to the Maori settlement we observed a few plants—certainly not more than half a dozen—of the handsome *Hibiscus diversifolius*. It was originally discovered in this locality by the Rev. Mr. Colenso, in the year

1839, and was also noticed by the Rev. R. Taylor and others of the early travellers and explorers; but the first actual record of its occurrence in New Zealand was given by Mr. Kirk in the "Transactions of the New Zealand Institute" for 1868. It was once comparatively plentiful in Spirits Bay, but the introduction of cattle, and frequent fires, have now pretty well exterminated it. The few plants we noticed have been preserved only on account of their growing in a swamp too wet to be crossed by cattle or easily burnt. Fortunately it still lingers in other parts of the North Cape peninsula, but it is much to be feared that its ultimate extinction is only a question of time. Naturalised plants were abundant in the Maori cultivations, the most interesting being *Sisyrinchium micranthum*, which has not been previously recorded from New Zealand.

Immediately to the eastward of Kapowairua, and lying between it and Tom Bowline's Bay, is a rough and rugged district mainly composed of basaltic conglomerate. Curious peaked and dome-shaped hills are abundant, and everywhere huge masses of basaltic rock protrude from the surface. The highest peak, Uruwhao, has an altitude of 995ft., but several other summits almost equal it. One known by the name of Hairoa is remarkable from possessing a curious vault or cave near the summit, from which the surrounding country can be viewed. It is mentioned by Dieffenbach, and is sure to attract the attention of all travellers. A branch of the Kapowairua rises almost at the foot of this hill, and, flowing through a narrow gorge, drops abruptly on to the flat below by a pretty little waterfall of about 30ft. in height. That portion of the gorge just above the fall is most picturesque. The little stream winds among huge rocks of all sizes and shapes piled together in the wildest confusion. The sides of the valley are precipitous and wall-like, here and there worn into hollows and small caves. One of the chief burial-places of the Aopuri Tribe is said to be concealed somewhere in the recesses of this valley, which is hence held as extremely *tapu* by the Maoris. The vegetation is principally light bush, the chief trees being the pohutukawa, puriri, tarairi, *Dysoxylum*, *Leptospermum ericoides*, *Pittosporum umbellatum*, *Hoheria*, *Sophora*, *Alectryon*, and *Olearia angulata*. In sheltered nooks by the side of the stream were large masses of *Colensoa*, its pretty blue flowers giving it a very attractive appearance. Clumps of *Todea hymenophylloides* were seen, but no *Hymenophylla* or *Trichomanes*. To the north and east of Uruwhao and Hairoa is quite an extensive area covered with light forest, apparently mainly composed of the trees mentioned above; but time would only allow us to examine a small portion. Still further to the eastward, and stretching as far as Tom

Bowline's Bay, is a high table-land, mostly open and covered with a scanty vegetation of *Leptospermum* and *Pteris*. The declivities towards the sea, however, are mostly clothed with light bush.

Only a portion of the coast-line between Tom Bowline's Bay and Hooper's Point could be examined. In many places the shore is lined with tall craggy cliffs of basaltic conglomerate, on which were noticed occasional plants of *Asplenium obtusatum* and *Coprosma baueriana*, but little other vegetation. Here and there are sheltered nooks and bays, mostly filled with pohutukawa-trees, mixed with a few plants of *Sapota*. *Ipomœa palmata* presented a gorgeous sight in these localities, often climbing to the tops of the trees, and everywhere laden with its magnificent mauve-coloured flowers. Other noteworthy plants were *Coprosma kirkii*, *Hymenanthera latifolia* (by no means common), *Sicyos angulatus*, and *Siegesbeckia orientalis*.

Tom Bowline's Bay is rather more than two miles long, and is sandy from end to end. It is lined by a chain of low sandhills not exceeding 30ft. or 40ft. in height, mainly covered with *Cassinia* and *Coprosma acerosa*, although most of the common arenarian plants are also represented. Immediately behind the sandhills is the Waikuku Flat, a sandy or peaty tract only slightly raised above high-water mark, and which stretches across to the eastern coast, a distance of rather more than two miles. A considerable portion of the flat is occupied by a Maori settlement and its cultivations, and the remainder is covered with tea-tree and *Pteris*. At the extreme western end of the bay, and not far from the banks of the Waitangi Stream, I was pleased to find large patches of *Hibiscus diversifolius* growing with great freedom and vigour, and loaded with flowers. Its congener, *H. trionum*, was also noticed, and in still greater abundance.

The North Cape proper, which we now proceeded to examine, is a high promontory with a broad and flat table-like top, the average height of which is about 600ft. It is cut off from the rest of the district by the Waikuku Flat, and at no very distant geological epoch has been an island. Even at the present time a depression of less than 25ft. would again sever it from the mainland. It is about four miles in length, by perhaps three in greatest breadth. It is surrounded by steep and often inaccessible cliffs, usually washed by the sea, so that progress along the beach, except for short distances, is difficult or quite impracticable. On the top of the promontory the vegetation is excessively sparse and scanty. The surface soil is mostly composed of a bright-red clay or laterite, which is naturally infertile, and from its stiff and tenacious nature, and the absence of free drainage, is choked with water in

winter and spring and baked as hard as stone in summer. The predominant plant over hundreds of acres was *Schœnus tenax*, mixed here and there with *Pomaderris edgerleyi*, or stunted *Leptospermum*. But on the northern side, however, and especially to the eastward of Kerr Point, we gathered many interesting plants on the declivities leading to the edge of the cliffs. Among them may be mentioned a new species of *Cassinia*, with much of the appearance of *C. vauvilliersii*, but of dwarfer habit. The heads are narrower, containing fewer florets, and the scales among the florets are usually wanting, so that the plant might with perfect propriety be referred to the *Ozothamnus* section of *Helichrysum*. A curious prostrate *Coprosma* with orbicular fleshy leaves and finely-pubescent branches was not uncommon. It is clearly distinct from any described species, but in the absence of flowers and mature fruit it seems hardly advisable to describe it. A puzzling *Haloragis*, with the flowers and fruit of *H. alata*, and with foliage approaching that of *H. tetragyna*, var. *a*, was gathered in several places. A variety of *Geniostoma ligustrifolium*, with leaves less than half the size of the type and exceedingly thick and fleshy, was also observed. At the very edge of the cliffs the slopes were usually covered with *Veronica speciosa*, which occurs in immense profusion. Except in very sheltered places, it seldom rises more than a couple of feet from the ground, but, as the branches are closely interlaced and spread far and wide just above the ground, a single plant often forms a clump 2 yards or more in diameter. At the time of our visit it was just coming into bloom—two or three weeks later the cliffs would present a charming appearance from the multitudes of its crimson flowers. Other plants of interest noticed were *Pittosporum pimeleoides*, *P. umbellatum*, *Melicope simplex*, *Panax lessonii*, *Corokia cotoneaster*, *Olearia angulata*, &c. I was much surprised to find numerous patches of a dwarf variety of *Phyllocladus trichomanoides*, growing from 4ft. to 6ft. in height. Many of the plants were evidently of great age, and were loaded with fruit. In its mode of growth it reminded me of *Podocarpus nivalis*, so common on the mountains of the South Island, or of the stunted specimens of *Phyllocladus alpinus* sometimes seen at the upper limits of the mountain forests of Nelson and Canterbury.

The vegetation gradually lost its interesting features as we travelled in an easterly direction. The cliffs became less abrupt, and were principally covered with *Phormium* and *Arundo*, with scattered patches of pohutukawa and karaka. The extreme eastern portion, to which the name of the North Cape is usually confined, consists of an island perhaps 150ft. in height separated from the mainland by a narrow channel dry at low water. Rounding this, we skirted the southern

shore of the promontory. One or two of the gullies contained small patches of bush, composed of common species, so far as we had time to examine them, and on the hills the dreary vegetation of *Schœnus tenax* again appeared. No change of importance took place until the southern side of the Waikuku Flat was reached.

Leaving the neighbourhood of the North Cape, and travelling southwards along the eastern coast, we reached Wharekau, finding *Ipomœa* and *Fuchsia procumbens* plentiful along the beach, while *Hibiscus trionum* was abundant on the sides of the hills, growing among the short *Leptospermum*. Passing Whareama, where there are some small patches of forest sheltering caves said to be former burial-places of the Aopuri, we slowly made our way along the coast, finding the vegetation scanty and uninteresting. We passed Maukin's Nook, Mokaikai, and Otuo, and, striking inland from the last-mentioned place, a walk of three or four miles brought us to the Maori settlement at the north head of Parengarenga Harbour. This virtually brought our explorations to a close, and on the following day we took our departure by the little steamer "Staffa" for Mangonui and Auckland.

The subjoined catalogue of the flowering-plants and ferns observed in the district contains the names of 416 species. This is a small number for so large an area; and, although it will be increased by future explorers, yet there can be no doubt that the flora is a poor one. The sameness of the physical conditions is in some measure responsible for this, and the almost total absence of forest is another powerful reason. In a hilly and forest-clad district many plants flourish that have no chance of existence on the bare hill-sides and open gullies of the North Cape peninsula. But the flora is poor, not only as regards the total number of species, but also from the point of view of its general aspect. Almost everywhere the landscape has an arid and sterile appearance. On the open hillsides the vegetation is low and stunted, uniform in character over large areas, and monotonous and depressing to a degree. The long stretches of sand-dunes, either altogether bare or thinly clothed with their peculiar vegetation—a vegetation which is specially remarkable for its poverty and persistence over wide areas—add greatly to the general appearance of sterility. And the few patches of bush are poor representatives of the magnificent forests which stretch from Hokianga southwards. The trees are small, of few kinds, and we nowhere find the deep and densely-shaded fern gullies with their wealth of varied and luxuriant foliage. In short, any idea that the flora of the extreme north possesses increased luxuriance, due to its more northerly situation and warmer climate, may be dismissed at once, for in

point of fact the vegetation cannot compare in richness and luxuriance with that of many districts far to the south.

A few remarks on the composition of the flora may not be out of place. As stated above, the total number of species catalogued is 416; but there should be added to the list a few plants observed on the Three Kings Islands, which must be regarded as a part of the district. These number ten, five of which—*Pittosporum fairchildi*, *Coprosma macrocarpa*, *Veronica insularis*, *Paratrophis smithii*, and *Davallia tasmani*—are endemic. The five remaining species, which, although found elsewhere in New Zealand, have not yet been observed within the limits of the North Cape peninsula, are *Angelica rosæfolia*, *Meryta sinclairii*, *Myosotis spathulata*, *Pisonia umbellifera*, and *Lomaria acuminata* We have therefore to deal with a flora of 426 species, distributed in 78 natural orders. The largest orders are *Filices*, with 46 species; *Cyperaceæ*, 41; *Compositæ*, 28; *Gramineæ*, 23; *Rubiaceæ*, 17; *Orchideæ*, 15. The largest genera are *Coprosma*, with 13 species; *Carex*, 9; *Pittosporum* and *Epilobium*, 8 each; *Scirpus* and *Cladium*, with 6 each. The following species (including some plants of wide range beyond New Zealand) are either confined to the district or occur only in small quantity in other portions of the colony: *Pittosporum fairchildi*, *Hibiscus diversifolius*, *Haloragis cartilaginea*, *Meryta sinclairii*, *Coprosma macrocarpa*, *C. kirkii*, *C. n. sp.*, *Olearia angulata*, *Cassinia amœna*, *Colensoa physaloides*, *Ipomœa palmata*, *Veronica insularis*, *Cassytha paniculata*, *Paratrophis smithii*, *Kyllinga monocephala*, *Davallia tasmani*, *Lomaria acuminata*, *Todea barbara*, *Lycopodium drummondii*.

If the question should be asked as to whether a tropical element shows itself in the flora, the answer must be that such is barely discernible. The proof, such as it is, would lie almost altogether in the presence of the five following species: *Hibiscus diversifolius*, *Ipomœa palmata*, *Cassytha paniculata*, *Nephrodium unitum*, and *Todea barbara*. A trace of Polynesian affinity may possibly be indicated by such species as *Meryta sinclairii*, *Colensoa physaloides*, *Paratrophis smithii*, and a few others. It is a curious anomaly that tropical species, or endemic species of tropical genera, should exist in some numbers in both Norfolk Island and Lord Howe's Island and yet have been unable to reach the northern extremity of New Zealand, or, with but few exceptions, even the Kermadec Islands.

A comparison of the flora of the North Cape district with that of other portions of the North Island would unduly extend the limits of this paper. It would also involve a reconsideration of the whole question of the distribution within the colony of the species of the New Zealand flora, a

matter which is of sufficient importance to receive separate treatment.

CATALOGUE OF THE FLOWERING-PLANTS AND FERNS OBSERVED IN THE DISTRICT BETWEEN MANGONUI AND THE NORTH CAPE.

RANUNCULACEÆ.

Clematis indivisa, Willd. Not uncommon throughout the district.

Clematis fœtida, Raoul. Ahipara.

Clematis parviflora, A. Cunn. Ahipara.

Ranunculus plebeius, R. Br. Abundant throughout the district.

Ranunculus rivularis, Banks and Sol. Common in wet swamps.

Ranunculus acaulis, Banks and Sol. Brackish-water marshes and moist sandy shores, plentiful.

CRUCIFERÆ.

Nasturtium palustre, DC. Vicinity of Mangonui.

Lepidium oleraceum, Forst. Cliffs near the North Cape.

Cardamine hirsuta, L. Not uncommon.

VIOLARIEÆ.

Melicytus ramiflorus, Forst. Common.

Hymenanthera latifolia, Endl. Coast near Ohora; Pukekarea, near Tapotopoto Bay; between Tom Bowline's Bay and Hooper's Point.

PITTOSPOREÆ.

Pittosporum tenuifolium, Gærtn. Abundant throughout the district.

Pittosporum pimeleoides, A. Cunn. North Cape extreme.

Pittosporum reflexum, R. Cunn. Between Mangonui and Flat Head

Pittosporum umbellatum, Gærtn. Mangonui Harbour, and coast between Mangonui and Whangaroa; Spirits Bay.

Pittosporum virgatum, Kirk. Coast between Mangonui and Whangaroa.

Pittosporum crassifolium, Sol. Coast between Mangonui and Whangaroa.

Pittosporum cornifolium, A. Cunn. Vicinity of Mangonui.

CARYOPHYLLEÆ.

Stellaria parviflora, Banks and Sol. Vicinity of Mangonui.

Colobanthus billardieri, Fenzl. Reported from Ohora by Mr. Buchanan. I failed to find it.

Spergularia rubra, Presl. North Cape.

HYPERICINEÆ.

Hypericum japonicum, Thunb. Low grounds in the Awanui Valley, and between Kaitaia and Ahipara.

MALVACEÆ.

Plagianthus divaricatus, Forst. Brackish-water marshes, plentiful.

Plagianthus betulinus, A. Cunn. Near Kaitaia.

Hoheria populnea, A. Cunn. Abundant throughout the district.

Hibiscus diversifolius, Jacq. Reef Point, Ahipara; Spirits Bay; Tom Bowline's Bay.

Hibiscus trionum, L. Te Kao; Tom Bowline's Bay; between the North Cape and Maukin's Nook.

TILIACEÆ.

Entelea arborescens, Br. Not uncommon throughout the district.

Aristotelia racemosa, Hook. f. From Mangonui to Ahipara.

Elæocarpus dentatus, Vahl. From Mangonui to Ahipara; between Tapotopoto Bay and Spirits Bay.

LINEÆ.

Linum monogynum, Forst. Vicinity of Mangonui.

GERANIACEÆ.

Geranium dissectum, L., var. *carolinianum*. Common throughout the district.

Geranium microphyllum, Hook. f. Vicinity of Mangonui; Whangakea; Tom Bowline's Bay.

Geranium molle, L. Common throughout the district.

Pelargonium australe, Jacq. Abundant throughout the district.

Oxalis corniculata, L. Generally distributed.

RUTACEÆ.

Melicope ternata, Forst. Ahipara; in several localities between Cape Reinga and the North Cape.

Melicope simplex, A. Cunn. Cliffs at the North Cape.

MELIACEÆ.

Dysoxylum spectabile, Hook. f. Scattered all through the district.

RHAMNEÆ.

Pomaderris elliptica, Labill. Common throughout the district, on clay hills.

Pomaderris edgerleyi, Hook. f. Open hillsides to the north of Parengarenga Harbour, abundant.

Pomaderris phylicifolia, Lodd. Throughout the district.

Sapindaceæ.

Dodonæa viscosa, Jacq. Plentiful.
Alectryon excelsum, Gærtn. Not uncommon.

Anacardiaceæ.

Corynocarpus lævigatus, Forst. An abundant coast plant.

Coriarieæ.

Coriaria ruscifolia, L. Common throughout the district.

Leguminosæ.

Carmichælia australis, Br. Generally distributed.
Sophora tetraptera, Mill. From Mangonui to Ahipara; and from Spirits Bay to Tom Bowline's Bay.

Rosaceæ.

Rubus australis, Forst. Not uncommon.
Acæna sanguisorbæ, Vahl. Generally distributed.

Saxifrageæ.

Carpodetus serratus, Forst. Oruru Valley; near Kaitaia; Whangakea.
Aokama rosæfolia, A. Cunn. Oruru Valley.
Weinmannia sylvicola, Sol. From Mangonui to Ahipara; Ohora.

Crassulaceæ.

Tillæa sieberiana, Schult. (*T. verticillaris*, DC.) Ohora.

Droseraceæ.

Drosera pygmæa, DC. Low peaty flats at Te Paua, Parengarenga; abundant, but easily overlooked.
Drosera spathulata, Labill. Head of Doubtless Bay.
Drosera binata, Labill. Abundant in swamps throughout the district.
Drosera auriculata, Backh. Open hillsides; not uncommon.

Halorageæ.

Haloragis alata, Jacq. Generally distributed.
Haloragis cartilaginea, Cheeseman. Cliffs near the North Cape; not common.
Haloragis tetragyna, Labill. The typical form and var. *diffusa* both common throughout the district.
Haloragis depressa, Walp. Not uncommon in the vicinity of Mangonui.
Haloragis micrantha, R. Br. Generally distributed.
Myriophyllum intermedium, DC. (*M. variæfolium*, Hook. f.). Not uncommon in lakes and streams throughout the district.

Myriophyllum pedunculatum, Hook. f. Moist sandy places; not uncommon. Ahipara; between Matapia and Pukekarea; Spirits Bay, &c.

Gunnera monoica, Raoul. Oruru Valley.

Gunnera arenaria, Cheeseman. Between Matapia and Cape Maria van Diemen.

Callitriche muelleri, Sond. Throughout the district in moist shady places.

MYRTACEÆ.

Leptospermum scoparium, Forst. Common throughout.

Leptospermum ericoides, A. Rich. Abundant.

Metrosideros florida, Smith. Vicinity of Mangonui.

Metrosideros hypericifolia, A. Cunn. Between Mangonui and Ahipara.

Metrosideros robusta, A. Cunn. In woods from Mangonui to Ahipara; between Tapotopoto Bay and Whangakea.

Metrosideros tomentosa, A. Rich. Abundant on the coast.

Metrosideros scandens, Sol. From Mangonui to Ahipara; Ohora; from Tapotopoto to Whangakea; Kapowairua.

Myrtus bullata, Sol. From Mangonui to Ahipara; Tapotopoto to Whangakea.

Eugenia maire, A. Cunn. Mangatete; near Kaitaia; Tapotopoto.

ONAGRARIEÆ.

Fuchsia excorticata, Linn. fil. Not uncommon throughout the district.

Fuchsia procumbens, R. Cunn. Not uncommon along the coast. Ahipara; Waihi; Ohora; Maunganui Bluff to Cape Maria; in several places from Cape Reinga to the North Cape.

Epilobium nummularifolium, R. Cunn. Common throughout the district.

Epilobium alsinoides, A. Cunn. Ahipara.

Epilobium rotundifolium, Forst. Low grounds; Kaitaia and Ahipara.

Epilobium billardierianum, Seringe (Haussk. Monog. Epilob., 293, *non* Hook. fil.) Not uncommon.

Epilobium junceum, Forst. Plentiful throughout the district.

Epilobium pubens, A. Rich. Not uncommon.

Epilobium pallidiflorum, Sol. Not uncommon in swamps.

Epilobium chionanthum, Haussk. Ahipara; Waihi; Spirits Bay.

CUCURBITACEÆ.

Sicyos angulatus, L. Between Tom Bowline's Bay and Hooper's Point; not common.

Ficoideæ.

Mesembryanthemum australe, Sol. Abundant on rocky coasts.
Tetragonia expansa, Murray. Mangonui Harbour and shores of Doubtless Bay; Ohora; near Cape Maria van Diemen.
Tetragonia implexicoma, Hook. f. Cliffs near the North Cape.

Umbelliferæ.

Hydrocotyle elongata, A. Cunn. Vicinity of Mangonui; Kaitaia; near Tom Bowline's Bay.
Hydrocotyle asiatica, L. Common throughout the district.
Hydrocotyle pterocarpa, F. Muell. Swamps near Awanui; Lake Tongonge.
Hydrocotyle novæ-zealandiæ, DC. Vicinity of Mangonui, Ohora, &c. Not uncommon in swamps and moist ground.
Hydrocotyle moschata, Forst. Several localities between Mangonui and Ahipara.
Apium australe, Thou. Common on the shores.
Apium filiforme, Hook. Mangonui Harbour; Ohora; Tapotopoto Bay.
Crantzia lineata, Nutt. Common all through the district in brackish-water marshes and moist sandy ground.
Daucus brachiatus, Sieber. Between Oruru and the head of Doubtless Bay; Spirits Bay and Kapowairua.

Araliaceæ.

Panax arboreum. Forst. Frequently seen between Mangonui and Ahipara; between Tapotopoto Bay and Whangakea.
Pseudopanax crassifolium, C. Koch. Near Mangonui; Kaitaia; Ahipara; in several localities between Cape Reinga and the North Cape.
Pseudopanax lessonii, C. Koch. Coast-line near Mangonui; Ohora; cliffs at the North Cape.
Schefflera digitata, Forst. Vicinity of Mangonui; in many places between the Reinga and the North Cape.

Corneæ.

Corokia cotoneaster, Raoul. Plentiful between the Reinga and the North Cape.
Griselinia lucida, Forst. Vicinity of Mangonui; near Tapotopoto Bay.

Caprifoliaceæ.

Alseuosmia macrophylla, Forst. Vicinity of Mangonui.
Alseuosmia quercifolia, A. Cunn. Vicinity of Mangonui.

Rubiaceæ.

Coprosma lucida, Forst. Not uncommon.
Coprosma grandifolia, Hook. f. Vicinity of Mangonui; Ohora.

Coprosma baueri, Endl. Common on maritime cliffs throughout the district.
Coprosma robusta, Raoul. Plentiful.
Coprosma cunninghamii, Hook. f. Banks of the Waihopu Stream, Ohora.
Coprosma spathulata, A. Cunn. Vicinity of Mangonui; in several localities between Cape Reinga and the North Cape.
Coprosma arborea, T. Kirk. Coast near Mangonui; Mangatete; Kapowairua.
Coprosma rhamnoides, A. Cunn. Vicinity of Mangonui, and northwards to the North Cape.
Coprosma parviflora, Hook. f. Abundant throughout the district.
Coprosma kirkii, Cheeseman, n. sp. Ahipara Bay; between Tapotopoto and Whangakea; near Tom Bowline's Bay.
Coprosma n. sp. Cliffs near the North Cape.
Coprosma acerosa, A. Cunn. Abundant on sandhills throughout the district.
Nertera dichondræfolia, Hook. f. Vicinity of Mangonui.
Nertera sp. Pukekarea; between Maukin's Nook and Parengarenga.
Galium umbrosum, Sol. Common throughout the district.

COMPOSITÆ.

Lagenophora forsteri, DC. Common all through the district.
Lagenophora petiolata, Hook. f. Near Mangonui.
Lagenophora lanata, A. Cunn. Hills near Tokomata.
Olearia furfuracea, Hook. f. Mangonui Harbour; slopes of Mount Camel, Ohora.
Olearia cunninghamii, Hook. f. Vicinity of Mangonui.
Olearia angulata, T. Kirk. Abundant on the coast at Ahipara, and between the Reinga and the North Cape.
Gnaphalium keriense, A. Cunn. Vicinity of Mangonui.
Gnaphalium luteo-album, L. Generally distributed throughout the district.
Gnaphalium japonicum, Thunb. Generally distributed throughout the district.
Gnaphalium collinum, Labill. Generally distributed throughout the district.
Helichrysum (Ozothamnus) glomeratum, Hook. f. Kapowairua; cliffs at the North Cape.
Cassinia leptophylla, DC. Abundant throughout the district.
Cassinia amœna, Cheeseman, n. sp. Cliffs at the North Cape; not uncommon.
Bidens pilosa, L. Coast near Mangonui; in several places between Cape Reinga and the North Cape.

Cotula coronopifolia, L. Abundant in moist places throughout the district.
Cotula australis, Hook. f. Vicinity of Mangonui.
Cotula minor, Hook. f. Dripping cliffs at Waihi.
Centipeda orbicularis, Lour. Low grounds, Awanui Valley.
Erechtites prenanthoides, DC. Parerau; near Ahipara.
Erechtites arguta, DC. Generally distributed.
Erechtites scaberula, Hook. f. Generally distributed.
Erechtites quadridentata, DC. Generally distributed.
Brachyglottis repanda, Forst. Common throughout the district.
Senecio lautus, Sol. On maritime rocks; not uncommon.
Senecio glastifolius, Hook. f. Vicinity of Mangonui.
Picris hieracioides, L. Common on dry hills throughout the district.
Taraxacum officinale, Wigg. Not uncommon.
Sonchus oleraceus, L. Plentiful throughout.

GOODENOVIEÆ.

Selliera radicans, Cav. Abundant in salt marshes throughout the district.

CAMPANULACEÆ.

Pratia angulata, Hook. f. Moist ground by the side of streams; not uncommon.
Colensoa physaloides, Hook. f. Gullies at the base of Mount Camel; sides of streams at Kapowairua; and between Tom Bowline's Bay and Hooper's Point.
Lobelia anceps, Linn. f. Common throughout the district.
Wahlenbergia gracilis, A. DC. Generally distributed.

ERICACEÆ.

Gaultheria antipoda, Forst. Various localities near Mangonui; not uncommon to the north of Parengarenga.

EPACRIDEÆ.

Cyathodes acerosa, Br. Plentiful throughout the district.
Leucopogon fasciculatus, A. Rich. Common throughout the district in open situations.
Leucopogon fraseri, A. Cunn. Common throughout the district in open situations.
Epacris pauciflora, A. Rich. Common throughout the district in open situations.
Dracophyllum latifolium, A. Cunn. Vicinity of Mangonui.
Dracophyllum squarrosum, Hook. f. Slopes of Tirikawa, near Tapotopoto. A large, much-branched form.
Dracophyllum urvilleanum, A. Rich. Common in open situations.

PRIMULACEÆ.

Samolus repens, Pers. Common in brackish-water marshes and along the coast generally.

MYRSINEÆ.

Myrsine salicina, Heward. Near Mangonui.
Myrsine urvillei, A. DC. Generally distributed in woods.

SAPOTACEÆ.

Sideroxylon costatum, F. Muell. Coast near Mangonui; Ohora; not uncommon along the coast from Cape Reinga to the North Cape.

OLEACEÆ.

Olea lanceolata, Hook. f. Vicinity of Mangonui; near Tapotopoto Bay.

APOCYNACEÆ.

Parsonsia albiflora, Raoul. Common throughout the district.
Parsonsia rosea, Raoul. Ahipara; Tom Bowline's Bay.

LOGANIACEÆ.

Geniostoma ligustrifolium, A. Cunn. Plentiful throughout the district.
Geniostoma ligustrifolium, var. *crassifolium*. Cliffs at the North Cape.

CONVOLVULACEÆ.

Ipomœa palmata, Forst. Between Mangonui and Whangaroa, Reef Point, Ahipara; Ohora; not uncommon on the coast from Cape Maria van Diemen to the North Cape.
Calystegia sepium, Br. Abundant.
Calystegia tuguriorum, Br. Vicinity of Mangonui.
Calystegia soldanella, Br. Everywhere on sandy shores.
Calystegia marginata, Br. Near Tokomata Point, on the coast between Mangonui and Whangaroa.
Dichondra repens, Forst. Abundant.

SOLANACEÆ.

Solanum aviculare, Forst. Generally distributed.
Solanum nigrum, L. Generally distributed.

SCROPHULARINEÆ.

Mimulus repens, Forst. Brackish-water swamps at Spirits Bay, abundant.
Mazus pumilio, Br. Reef Point, Ahipara; moist ground at Waihi.
Gratiola peruviana, L. Ahipara; Ohora.
Glossostigma elatinoides, Benth. Common in wet swamps and by the margin of lakes.

Limosella aquatica, L., var. *tenuifolia*. Moist, sandy ground by the margin of lakes.
Veronica speciosa, R. Cunn. Pukekarea, scarce; cliffs at the North Cape, abundant.
Veronica salicifolia, Forst. Abundant throughout the district.
Veronica diosmæfolia, R. Cunn. Reef Point, Ahipara; Ohora; between Cape Reinga and Tapotopoto.
Veronica plebeia, R. Br. (*V. elongata*, Benth). Low grounds, Awanui to Kaitaia and Ahipara.

GESNERACEÆ.

Rhabdothamnus solandri, A. Cunn. Not uncommon throughout the district.

MYOPORINEÆ.

Myoporum lætum, Forst. Generally distributed.

VERBENACEÆ.

Vitex littoralis, A. Cunn. Common in suitable localities throughout the country.
Avicennia officinalis, L. Mangonui Harbour; Rangaunu Harbour; Ohora; Parengarenga; Tapotopoto.

LENTIBULARIEÆ.

Utricularia novæ-zealandiæ, Hook. f. Swamps at Lake Ohia.
Utricularia colensoi, Hook. f. Sphagnum swamps at Mangatete.

LABIATÆ

Mentha cunninghamii, DC. Common in grassy places throughout the district.

PLANTAGINEÆ.

Plantago raoulii, Dcne. Common in moist places throughout the district, especially near the sea.

ILLECEBRACEÆ.

Scleranthus biflorus, Hook. f. Not uncommon in dry places, sandhills, &c.

AMARANTACEÆ.

Alternanthera sessilis, R. Br. Oruru; near Awanui.

CHENOPODIACEÆ.

Chenopodium glaucum, L. Not uncommon in brackish-water swamps.
Chenopodium ambrosioides, L. Maori cultivations at Te Kao, Parengarenga.
Chenopodium carinatum, R. Br. Near Mangonui.
Rhagodia nutans, Br. Ohora; Cape Maria van Diemen.

Salsola kali, L. Common on sandy beaches, but in all probability introduced.

Salicornia australis, Sol Common along the shores, except in dry sandy places.

Suæda maritima, Dum. Salt marshes in Mangonui Harbour.

Atriplex billardieri, Hook. f. Tom Bowline's Bay, not common.

POLYGONACEÆ.

Polygonum minus, Huds. Abundant in swamps throughout the district.

Polygonum aviculare, L. Common in waste places.

Rumex flexuosus, Sol. Not uncommon.

Muhlenbeckia australis, Meisn. Abundant throughout.

Muhlenbeckia complexa, Meisn. Abundant throughout.

PIPERACEÆ.

Piper excelsum, Forst. Common throughout the district.

Peperomia endlicheri, Miq. Generally distributed.

MONIMIACEÆ.

Hedycarya arborea, Forst. Mangonui to Ahipara, in woods; in several places between Cape Reinga and the North Cape.

Laurelia novæ-zealandiæ, A. Cunn. Between Awanui and Kaitaia.

LAURINEÆ.

Beilschmiedia tawa, Benth. and Hook. f. Mangonui to Ahipara; Kapowairua.

Beilschmiedia tarairi, Benth. and Hook. f. Common in woods throughout the district.

Litsæa calicaris, Hook. f. Common in woods throughout the district.

Cassytha paniculata, R. Br. Common in open situations throughout the district, parasitic on *Leptospermum*.

PROTEACEÆ.

Persoonia toro, A. Cunn. Vicinity of Mangonui.

Knightia excelsa, R. Br. In woods throughout the district.

THYMELEÆ.

Pimelea virgata, Vahl. Ahipara; Ohora.

Pimelea arenaria, A. Cunn. Abundant on sandhills throughout the district.

Pimelea lævigata, Gærtn. (*P. prostrata*, Willd). Not uncommon throughout the district.

SANTALACEÆ.

Fusanus cunninghamii, Hook. f. Vicinity of Mangonui.

EUPHORBIACEÆ.

Euphorbia glauca, Forst. Common on sandy shores throughout the district.

URTICACEÆ.

Paratrophis heterophylla, Blume. Vicinity of Mangonui.

Elatostemma rugosum, A. Cunn. Between Mangonui and Ahipara.

Parietaria debilis, Forst. Not uncommon throughout the district.

CONIFERÆ.

Phyllocladus trichomanoides, Don. From Mangonui to Ahipara; near Hooper's Point; cliffs near the North Cape (a dwarf form).

Dacrydium cupressinum, Sol. From Mangonui to Ahipara; between Tapotopoto and Whangakea.

Podocarpus ferruginea, Don. Vicinity of Mangonui.

Podocarpus totara, Don. From Mangonui to Ahipara; between Tapotopoto Bay and Whangakea.

Podocarpus spicata, R. Br. Vicinity of Mangonui.

Podocapus dacrydioides, A. Rich. From Mangonui to Ahipara; Lower Awanui; near the mouth of the Mangatete River; near Te Paki, Parengarenga.

Agathis australis, Steud. From Mangonui to Ahipara; from Tapotopoto Bay to Whangakea; scattered trees only.

ORCHIDEÆ.

Earina mucronata, Lindl. In several localities from Mangonui to Ahipara; Ohora.

Earina suaveolens, Lindl. (*O. autumnalis*). Oruru Valley.

Dendrobium cunninghamii, Lindl. From Mangonui to Ahipara.

Bulbophyllum pygmæum, Lindl. Oruru Valley.

Gastrodia cunninghamii, Hook. f. Near Kaitaia, Mr. Matthews!

Acianthus sinclairii, Hook. f. Vicinity of Mangonui.

Microtis porrifolia, Br. Not uncommon throughout the district.

Pterostylis banksii, R. Br. Vicinity of Mangonui.

Thelymitra longifolia, Forst. Abundant through the whole of the district.

Thelymitra pulchella, Hook. f. Vicinity of Mongonui, abundant.

Thelymitra imberbis, Hook. f. Vicinity of Mangonui.

Spiranthes australis, Lindl. Abundant in a swamp between Waihopu and Te Kao.

Prasophyllum colensoi, Hook, f. Three specimens picked in a swamp near Mangonui.

Prasophyllum pumilum, Hook. f. Between Parengarenga and Spirits Bay, T. Kirk.

Orthoceras solandri, Lindl. Not uncommon throughout the district.

IRIDEÆ.

Libertia ixioides, Spreng. Ahipara; Cape Maria van Diemen.

LILIACEÆ.

Rhipogonum scandens, Forst. From Mangonui to Ahipara, abundant in woods; Ohora.

Phormium tenax, Forst. Common throughout the district.

Cordyline australis, Hook. f. Generally distributed through the district.

Cordyline banksii, Hook. f. Near Mangonui: Ahipara; not uncommon in several places between Cape Reinga and the North Cape.

Cordyline pumilio, Hook. f. Vicinity of Mangonui.

Cordyline sp. Ahipara; cultivated in Mr. Reid's garden from plants obtained in the vicinity.

Astelia cunninghamii, Hook. f. Vicinity of Mangonui

Astelia solandri, A. Cunn. From Mangonui to Ahipara, abundant in woods; Ohora; in several places between Cape Reinga and the North Cape.

Astelia banksii, A. Cunn. Ohora; cliffs near the North Cape.

Astelia grandis, Hook. f. Not uncommon in clay swamps and by the side of gullies.

Astelia trinervia, Kirk. Near Mangonui; Ohora; Tapotopoto; Whangakea.

Arthropodium cirrhatum. Not uncommon in rocky places along the coast; Mount Camel, abundant.

Dianella intermedia, Endl. Common throughout the district.

JUNCACEÆ.

Juncus maritimus, L. Common in salt marshes throughout the district.

Juncus effusus, L. Common throughout the district.

Juncus planifolius, Br. Generally distributed.

Juncus bufonius. L. Generally distributed.

Luzula campestris, DC. From Mangonui to Ahipara.

PALMEÆ.

Rhopalostylis sapida, Wendl. and Druce. From Mangonui to Ahipara; near Tapotopoto.

PANDANEÆ.

Freycinetia banksii, A. Cunn. Throughout the district in suitable localities.

Typhaceæ.

Typha angustifolia, L. Common in swamps throughout the district.

Sparganium angustifolium, R. Br. Abundant in wet swamps throughout the district.

Lemnaceæ.

Lemna minor, L. Not uncommon in still clear water.

Naiadaceæ.

Triglochin striatum, Ruiz. and Pavon. Common in brackish-water swamps and by the margin of lakes.

Potamogeton cheesemanii, A. Bennett. Common in streams and lakes throughout the district.

Potamogeton polygonifolius, Pourr. Near Ohora.

Ruppia maritima, L. Brackish-water ponds; abundant.

Zostera marina, L. Common in all the harbours.

Restiaceæ.

Leptocarpus simplex, A. Rich. Plentiful in brackish-water marshes throughout the district; also frequently seen on the sand-dunes.

Hypolæna lateriflora, Benth. Swamps near Lake Ohia; vicinity of Ohora; swamps at Spirits Bay and near Tapotopoto.

Cyperaceæ.

Cyperus ustulatus, A. Rich. Abundant throughout the district.

Cyperus buchanani, Kirk. In immense abundance in the Oruaiti, Oruru, and Awanui Valleys.

Cyperus tenellus, Linn. f. Not uncommon throughout the district.

Kyllinga monocephala, Rottb. Now generally spread throughout the district in moist places. Doubtless introduced.

Eleocharis sphacelata, Br. Wet swamps and by the margins of lakes; not uncommon.

Eleocharis acuta, Br. Common throughout the district.

Eleocharis cunninghamii, Bœck. Common throughout the district.

Eleocharis neo-zealandica, Clarke. Moist sandy flats between Hukatere and Ohora.

Scirpus fluitans, L. Wet swamps near Ohora.

Scirpus cernuus, Vahl. (*S. riparius*, Br.). Common throughout the district.

Scirpus inundatus, Poir. Common throughout the district.

Scirpus nodosus, Rottb. Generally distributed.

Scirpus lacustris, L. Not uncommon in wet swamps.

Scirpus frondosus, Banks and Sol. (*Desmoschœnus spiralis*, Hook. f.). Common on sandhills throughout the district.

Schœnus axillaris, Poir. Generally distributed in moist places.

Schœnus apogon, Rœm. and Sch. (*S. brownii*, Hook. f.). Vicinity of Mangonui.

Schœnus tenax, Hook. f. Common throughout the district.

Schœnus tendo, Banks and Sol. Generally distributed.

Schœnus tenuis, Kirk. Generally distributed.

Lepidosperma australe, R. Br. Generally distributed.

Lepidosperma concava, R. Br. Generally distributed.

Cladium articulatum, Br. In swamps throughout the district.

Cladium glomeratum, Br. Lake Ohia; Lake Tongonge; swamps at Spirits Bay.

Cladium teretifolium, Br. Abundant in swamps throughout the district.

Cladium gunnii, Hook. f. Near Tapotopoto Bay; Kapowairua.

Cladium junceum, Br. Abundant in salt marshes throughout the district.

Cladium sinclairii, Hook. f. Sea-cliffs at Ahipara; abundant.

Gahnia lacera, Steud. Not uncommon throughout the district.

Gahnia xanthocarpa, Hook. f. Vicinity of Mangonui.

Gahnia gaudichaudii, Steud. (*G. arenaria*, Hook. f.). Common in dry places throughout the district.

Uncinia australis, Pers. Generally distributed.

Uncinia banksii, Boott. Near Mangonui.

Carex paniculata, L. The varieties *secta* and *virgata* are common in swamps throughout the district.

Carex ternaria, Forst. In several localities between Mangonui and Ahipara.

Carex lucida, Boott. Generally distributed.

Carex testacea, Sol. Head of Doubtless Bay; Ahipara.

Carex breviculmis, Br. Generally distributed in dry places.

Carex pumila, Thunb. Common on sandy coasts.

Carex dissita, Sol. Generally distributed.

Carex vacillans, Sol. Between Tapotopoto and Whangakea.

Carex pseudo-cyperus, L. Near Kaitaia.

GRAMINEÆ.

Microlæna stipoides, Br. Throughout the district.

Microlæna avenacea, Hook. f. Ahipara; in several localities between Cape Reinga and the North Cape.

Hierochloe redolens, Br. Margins of swamps: Ahipara; Ohora; Spirits Bay.

Spinifex hirsutus, Labill. Sandy coasts; abundant.

Paspalum scrobiculatum, L. Dry hills; plentiful throughout the district.

Paspalum distichum. Throughout the district in brackish-water swamps, and in moist, sandy places near the sea.

Oplismenus undulatifolius, Beauv. (*Panicum imbecille*, Trin.). Shady places in woods.

Isachne australis, Br. Common in swamps throughout the district.

Zoysia pungens, Willd. Common on sand-dunes.

Echinopogon ovatus, Beauv. Throughout the district.

Stipa teretifolia, Steud. Mangonui Harbour; Ohora; Tapotopoto; Spirits Bay. In brackish-water marshes.

Dichelachne crinita, Hook. f. Common throughout the district.

Sporobolus indicus, Br. Generally distributed.

Deyeuxia forsteri, Kunth. Throughout the district.

Deyeuxia billardieri, Kunth. Brackish-water swamps and rocky places near the sea; not uncommon.

Deyeuxia quadriseta, Benth. In various localities between Mangonui and Ahipara.

Arundo conspicua, Forst. Throughout the district, especially on sandhills and the sea-cliffs of the northern coasts.

Danthonia bromoides, Hook. f. Cliffs between Tokomata Point and Flat Head.

Danthonia semiannularis, Br. Throughout the district.

Trisetum antarcticum, Trin. Vicinity of Mangonui.

Poa anceps, Forst. Generally distributed.

Festuca littoralis, Lab. Sand-dunes; plentiful.

Triticum multiflorum, Banks and Sol. Vicinity of Mangonui Ahipara; in several places along the northern coast.

FILICES.

Gleichenia circinata, Swz. Vicinity of Mangonui.

Gleichenia dicarpa, Br., var. *hecistophylla*. Common in wet clay ground through the district.

Gleichenia flabellata, Br. Near Mangonui; Ohora; Parengarenga; Whangakea.

Gleichenia cunninghamii, Hew. Near Kaitaia.

Cyathea medullaris, Swz. Common in woods.

Cyathea dealbata, Swz. Common in woods.

Dicksonia squarrosa, Swz. Vicinity of Mangonui.

Hymenophyllum polyanthos, Swz. Between Mangonui and Ahipara; near Whangakea.

Hymenophyllum demissum, Swz.
Hymenophyllum flabellatum, Lab.
Hymenophyllum dilatatum, Swz.
Hymenophyllum tunbridgense, Sm.
Trichomanes reniforme, Forst.
} Between Mangonui and Ahipara, in woods; but not noticed in the extreme north of the district.

Loxsoma cunninghamii, Br. Between Mangonui Harbour and Flat Head, abundant; near Kaitaia, Mr. Carse.

Lindsaya linearis, Swz. Dry clay hills; plentiful throughout the district.

Adiantum diaphanum, Blume. Ohora; between Tom Bowline's Bay and Hooper's Point.

Adiantum affine, Willd. Common throughout the district.

Adiantum fulvum, Raoul. Near Mangonui; Kapowairua.

Adiantum æthiopicum, L. Ahipara; Tapotopoto.

Adiantum hispidulum, Swz. Common throughout the district.

Cheilanthes sieberi, Kunze. Ahipara; Mount Camel.

Hypolepis tenuifolia, Bern. Low grounds between Kaitaia and Ahipara; near Mangonui; Ohora; between Cape Reinga and Tapotopoto Bay.

Pellæa rotundifolia, Forst. In various localities between Mangonui and Ahipara; Ohora.

Pteris tremula, Br. Abundant throughout the district.

Pteris aquilina, L., var. *esculenta*. Generally distributed.

Pteris scaberula, A. Rich. Not uncommon in most parts of the district.

Pteris macilenta, A. Cunn Not uncommon in most parts of the district.

Pteris comans, Forst. Coast near Ohora.

Pteris incisa, Thunb. Plentiful from Mangonui to Ahipara; Kapowairua and near Tom Bowline's Bay.

Lomaria discolor, Willd. From Mangonui to Ahipara.

Lomaria lanceolata, Spr. From Mangonui to Ahipara; Ohora.

Lomaria banksii, Hook. f. Dripping rocks at Waihi, between Ahipara and Hukatere.

Lomaria procera, Spreng. Generally distributed.

Lomaria filiformis, A. Cunn. From Mangonui to Ahipara; in several localities between Tapotopoto Bay and the North Cape.

Doodia media, Br. Not uncommon throughout the district.

Asplenium obtusatum, Forst. Not uncommon. The typical form is plentiful on the cliffs of the northern coast.

Asplenium falcatum, Lam. In several localities between Mangonui and Ahipara; between Tapotopoto and Whangakea.

Asplenium hookerianum, Col. Near Kaitaia, Mr. Matthews!

Asplenium bulbiferum, Forst. Not uncommon in suitable places throughout the district.

Asplenium flaccidum, Forst. From Mangonui to Ahipara.

Asplenium japonicum, Thunb. Along the banks of the Awanui River below Kaitaia, Mr. Carse!

Aspidium richardi, Hook. In several localities between Mangonui and Ahipara; Ohora; Tapotopoto; Whangakea; Kapowairua, &c.

Aspidium capense, Willd. Vicinity of Mangonui.

Nephrodium thelypteris, Desv., var. *squamulosum*. Swamps near Lake Tongonge; Ahipara; Waihi; Ohora.

Nephrodium decompositum, Br. In several places between Mangonui and Ahipara.

Nephrodium velutinum, Hook. f. Ohora.

Nephrodium hispidum, Hook. In several places between Mangonui and Ahipara; Ohora.

Nephrodium unitum, Br. Swamps at Waihi, between Ahipara and Hukatere.

Polypodium punctatum, Thunb. Not uncommon throughout the district, in woods.

Polypodium pennigerum, Forst. Common throughout the district.

Polypodium tenellum, Forst. Near Tapotopoto; Kapowairua, Spirits Bay.

Polypodium serpens, Forst. Common throughout the district.

Polypodium cunninghamii, Hook. Vicinity of Mangonui; Tapotopoto; Kapowairua.

Polypodium pustulatum, Forst. In several places between Mangonui and Ahipara; Ohora; between Tapotopoto and Whangakea.

Polypodium billardieri, Br. Not uncommon throughout the district.

Todea barbara, Moore. Cooper's beach, near Mangonui; open gullies near Ohora; of frequent occurrence around Parengarenga Harbour, and between it and the northern coast.

Todea hymenophylloides, A. Rich. and Less. In several places between Mangonui and Ahipara; gullies near Te Kao, Parengarenga; between Tapotopoto and Whangakea; Kapowairua.

Schizæa fistulosa, Labill. Common amongst *Leptospermum* on clay hills.

Schizæa bifida, Swz. Common amongst *Leptospermum* on clay hills.

Lygodium articulatum, A. Rich. From Mangonui to Ahipara; near Tapotopoto.

Ophioglossum vulgatum, L. Moist grassy places; not uncommon.

Botrychium ternatum, Swz. Vicinity of Mangonui.

LYCOPODIACEÆ.

Lycopodium drummondii, Spring. This plant, which was referred to *L. carolinianum* in the "Handbook," was gathered within the district by Mr. Colenso, in 1839, but unfortunately the exact locality has been forgotten. I searched for it in vain.

Lycopodium billardieri, Spring. From Mangonui to Ahipara; between Tapotopoto and Spirits Bay.
Lycopodium densum, Labill. Throughout the district, on clay hills.
Lycopodium cernuum, L. Not uncommon through the district, on clay banks
Lycopodium laterale, Br. Margins of clay swamps; not uncommon
Lycopodium volubile, Forst. Not uncommon.
Tmesipteris tannensis, Bern. From Mangonui to Ahipara near Tapotopoto.

NATURALISED PLANTS.

Ranunculus sardous, Crantz. (*R. hirsutus*, Curt.)
Ranunculus muricatus, L
Nasturtium officinale, Br.
Brassica oleracea, L.
Capsella bursa-pastoris, DC.
Senebiera coronopus, Poir.
Senebiera pinnatifida, DC.
Raphanus sativus, L.
Silene gallica, L.
Cerastium glomeratum, Thuill.
Stellaria media, Cyr.
Spergula arvensis, L.
Polycarpon tetraphyllum, L.
Portulaca oleracea. L.
Hypericum perforatum, L.
Malva verticillata, L
Modiola multifida, Mœnch.
Linum marginale, A. Cunn.
Erodium cicutarium, L'Her.
Erodium maritimum, Sm.
Vitis vinifera, L.
Melianthus major, L.
Ulex europæus.
Medicago lupulina, L.
Medicago maculata, Willd.
Medicago denticulata, Willd.
Melilotus officinalis, Lam.
Trifolium pratense, L.
Trifolium glomeratum, L.
Trifolium resupinatum, L.
Trifolium repens, L.
Trifolium minus, Sm.
Lotus corniculatus, L.

Vicia tetrasperma, Mœnch.
Acacia longifolia, Willd.
Albizzia lophantha, Benth.
Amygdalus persica, L.
Rubus fruticosus, L.
Rosa rubiginosa, L.
Rosa multiflora, Thunb.
Lythrum hyssopifolium, L.
Œnothera, sp.
Apium graveolens, L.
Apium leptophyllum, F. Muell.
Sherardia arvensis, L.
Centranthus ruber, DC.
Valerianella olitoria, Pollich.
Scabiosa maritima, L. (= *S. atropurpurea*, L.).
Bellis perennis, L.
Erigeron canadensis, L.
Erigeron linifolius, Willd.
Siegesbeckia orientalis, L.
Anthemis arvensis, L.
Chrysanthemum leucanthemum, L.
Helenium quadridentatum, Labill.
Gnaphalium purpureum, L.
Cynara cardunculus, L.
Senecio vulgaris, L.
Senecio mikanoides, Otto.
Centaurea solstitialis, L.
Centaurea calcitrapa, L.
Cnicus lanceolatus, Willd.
Hypochæris radicata, L.
Lapsana communis, L.
Anagallis arvensis, L.
Vinca major, L.
Erythrea centaurium, Pers.
Solanum sodomæum, L.
Physalis peruviana, L.
Lycium chinense, Mill.
Verbascum blattaria, L.
Linaria elatine, Mill.
Veronica serpyllifolia, L.
Verbena officinalis, L.
Mentha viridis, L.
Mentha pulegium, L.
Prunella vulgaris, L.
Stachys arvensis, L.
Plantago major, L.
Plantago lanceolata, L.
Chenopodium murale, L.

Phytolacca octandra, L.
Rumex obtusifolius, L.
Rumex crispus, L.
Rumex sanguineus, L., var. *viridis*
Rumex acetosella, L.
Euphorbia peplus, L.
Ricinus communis, L.
Ficus carica, L.
Sisyrinchium micranthum, Cav.
Iris germanica, L.
Agave americana L.
Asparagus officinalis, L.
Allium vineale, L.
Asphodelus fistulosus, L.
Colocasia antiquorum, Schott
Panicum sanguinale, L.
Stenotaphrum glabrum, Trin.
Polypogon monspeliensis, Desf.
Polypogon fugax, Nees.
Phalaris canariensis, L.
Anthoxanthum odoratum, L.
Agrostis vulgaris, With.
Agrostis alba, L.
Aira caryophyllea, L.
Holcus lanatus, L.
Avena sativa, L.
Cynodon dactylon, L.
Eragrostis brownii, Nees.
Dactylis glomerata, L.
Briza minor, L.
Briza maxima, L.
Poa annua, L.
Poa pratensis, L.
Bromus sterilis, L.
Bromus mollis, L.
Bromus racemosus, L.
Bromus unioloides, H. B. K.
Lolium perenne, L.
Andropogon annulatus, Forsk.
Paspalum dilatatum.

ART. XXX.—*Notice of the Establishment of* Vallisneria spiralis *in Lake Takapuna, together with some Remarks on its Life-history.*

By T. F. CHEESEMAN, F.L.S.

[*Read before the Auckland Institute, 3rd August, 1896.*]

NEARLY three years ago my friend Major Mair showed me an aquatic plant which he had gathered in Lake Takapuna, and which he rightly concluded to be a stranger to our flora. When first seen it formed a dense mass of no great size in comparatively deep water in front of his boathouse, and several similar patches were noticed not far away, all being on the southern side of the lake. None of the residents near the lake knew the plant, and none of them could give him any information as to the mode of its introduction. I had little difficulty in identifying it as the well-kown *Vallisneria spiralis*, a common species in still water in most tropical and many temperate countries, and found plentifully as near to us as Australia and Tasmania. During the following summer additional specimens were brought to me by residents at the lake, all of whom agreed in stating that it was spreading rapidly on the southern shore of the lake, covering large areas in water varying from 6ft. to 15ft. in depth. During a short visit to the lake I saw the plant, and succeeded in obtaining flowering specimens. All of these were males, nor have any females been found up to the present time. In the winter of 1895, when the water of the lake stood at a high level, I heard but little of it, but towards the end of the spring, and during the past summer and autumn, the case was altogether different, and I was assured that it was increasing with extraordinary rapidity, and that it had already crossed the lake and had established fresh colonies in many places along the shores. In the original locality it had formed submerged masses of dense vegetation occupying areas of considerable size, in one or two cases blocking up the foreshore to such an extent as to compel the owners of boatsheds to clear passages in order to gain access to the lake. As the level of the water fell during the summer months the tips of the submerged leaves were laid bare, and where they were very numerous formed a compacted floating mass over which ducks and other aquatic birds walked as freely as on land. Every gale washed up numerous plants from shallow water, and these were frequently drifted to other portions of the lake, where they became rooted in the mud, thus forming fresh centres of distribution.

Although I had no doubt that *Vallisneria* had been purposely introduced, it was some time before evidence of the fact was obtained. I was at length informed by Mr. E. Bartley that in 1885 he received some living plants from Dr. Ralph, of Melbourne. These he cultivated for some time in a small aquarium in his garden, but eventually planted one of them, a male, in a secluded nook on the south side of the lake. A year or two afterwards he revisited the locality, and failing to find the specimen, concluded that it had died. It is from this single plant, however, that the lake has been stocked. As only one sex was planted, propagation by seed has been out of the question, and the whole of the plants now growing in the lake have been derived from offsets accidentally detached and drifted to fresh stations.

Vallisneria has increased so rapidly during the last two years, and has shown such aggressiveness and facility of distribution, that it will probably increase still further. Its spread in the past has naturally alarmed people not fully acquainted with the conditions of its growth, and surmises have been made to the effect that it will gradually spread into deeper water until a considerable portion of the lake is occupied with it The water-supply of the Borough of Devonport is drawn from Lake Takapuna, and the Mayor and Councillors of the borough have several times had under their consideration the probable effects of the spread of *Vallisneria* upon the purity of the water. I am of opinion, however, that there is little cause for alarm. From what I can learn of the growth of *Vallisneria* in other countries, it appears that it usually lives in water from 6ft. to 12ft. or 15ft. in depth, rarely or never flourishing in deeper water. It is precisely in waters of these depths that it has become established in Lake Takapuna, and beyond those limits it probably will not advance. Fortunately, Takapuna is a deep lake, a great portion of it varying from 12 to 25 fathoms in depth. In many places the shallow water fringing the shore is a mere strip, and with the exception of a bay at the northern end it is nowhere very wide. Consequently there is no risk of *Vallisneria* doing more harm than will result from the formation of a narrow fringe around the shores of the lake, interfering to some extent with bathing and boating.

The question at once suggests itself whether *Vallisneria*, having effected a lodgment in this country, will spread into other localities. The shallow lakes and sluggish streams of the middle Waikato basin are places where it might cause serious trouble by choking channels of drainage or even navigable streams. We have before us the instance of the American *Elodea* (*Anacharis*) *canadensis*, a plant closely allied to *Vallisneria*, which made its appearance in Britain about the

middle of this century, and in a few years spread over a great portion of the country. It caused an immense amount of harm by impeding the navigation of canals, interfering with the working of water-mills, and by choking the outlets of drainage-works and reservoirs, but of late years has shown signs of decrease. But *Elodea* is exceptionally well adapted for spreading into distant localities. Its slender branched stems are easily broken into fragments, any one of which is capable of reproducing the plant. In a country like Britain, with its network of inland navigation, it is easy to see how the passage of barges along canals might be the means of carrying the plant from place to place, to say nothing of the transporting of the fragments by currents or by aquatic birds. But *Vallisneria*, though capable of rapid increase in any locality where it becomes firmly established, is not so easily carried to a distance. Its stems are much stouter and heavier, and portions large enough to form fresh plants could not be carried by birds. Consequently it is hardly to be expected that it will spread by natural means from Lake Takapuna, which has no connection with other lakes or rivers.

The object of this paper was simply to place upon record the facts connected with the naturalisation of *Vallisneria* in the colony, and, having done this, perhaps I ought to conclude. But it has occurred to me that there are some questions connected with the life-history of the plant which, although well known to botanists, may not be equally familiar to others, and which are certainly both curious and interesting, and well worth the attention of any one who takes an interest in natural science. I allude to the remarkable manner in which the flowers are fertilised. With your permission, therefore, I will give you a brief account of the structure of the flowers and the mode of their fertilisation.

In the first place, for the sake of clearness, it is perhaps necessary to mention a few facts which are probably known to all who read this paper. In all flowering-plants, before perfect seed can be produced, it is requisite that the pollen, or male element, should be transferred to the pistil, or female portion of the flower. In the vast majority of flowering-plants this is effected in two ways, and in two ways only. These are, first, by the agency of wind, which simply blows the pollen from flower to flower. Our pine-trees, oaks, willows, most grasses and sedges are familiar examples of wind-fertilised plants. Secondly, by the aid of insects, birds, or other small animals, who, unconsciously to themselves, carry the pollen from flower to flower. Almost all plants having brightly-coloured or highly-perfumed flowers belong to this class. But in addition to these two main divisions some few plants exist—not numbering more than three or four score—

whose flowers are fertilised in quite a different manner, and of these *Vallisneria* is a typical example. In their case the pollen, instead of being blown by the wind or carried by insects, is conveyed to the female flower by means of rafts floating on the surface of the water. Let us now see how this takes place.

The stems of *Vallisneria* are short, and almost concealed by the mud amongst which they grow; but here and there they give off offsets or stolons. These are easily detached from the parent plant, and readily put down roots into the mud, thus starting life on their own account. It is by their means that the rapid increase of the species is insured when seeds are not produced, as is the case at Lake Takapuna. The leaves are in tufts at the top of the stem, and vary in length according to the depth of the water, sometimes being quite short, at other times reaching a length of 12ft., or even 15ft. They are always narrow for their length, resembling long ribbons, and float freely in the water with their tips just below the surface. Like many water-plants, they are so delicate in texture that if the water is removed they are unable to support their own weight, and sink limp and withered on the mud.

The flowers are unisexual, and the two sexes are borne on different plants. The male flowers are small and very numerous, and are closely packed within a delicate bladder-like spathe. Each little flower consists of three perianth leaflets, enclosing two or three stamens. The stalk which supports the flowers is short, seldom reaching more than 6in. above the surface of the mud, so that the flowers come to maturity far below the surface of the water. The female flower is single, and is at first enclosed within a long tubular spathe. It has three broad perianth leaflets, within which are three large fringed and lobed stigmas. The stalk of the female flowers lengthens in an extraordinary degree as the flower approaches maturity, and has been known to grow at the rate of more than a foot in twenty-four hours. When it reaches the surface of the water the tubular spathe splits, and the flower emerges, just floating above the surface. The stigmas protrude between the perianth leaflets, and the flower is ready for fertilisation.

It will naturally be asked how this can take place, seeing that the male flowers are matured close to the bottom of the water, often several feet below the level of the female flowers. But Nature is always full of resources, and the plan which is followed is as remarkable as any known in the whole range of the vegetable world. When the male flowers are perfectly mature the globular spathe which surrounds them splits into three pieces, which hang downwards out of the way.

The little flowers, still in the bud stage, then detach themselves one by one from the stalk, and, from their natural buoyancy, rise to the surface of the water. Having arrived there, they very shortly open, the three perianth leaflets bending backwards and downwards, thus forming a little raft, above which is borne the projecting stamens with their load of pollen. Although the pollen is so close to the water it is very seldom wetted, for the little raft responds to every movement, and rides over the waves quite as safely as many larger vessels. The male flowers are produced in such great profusion that the surface of the water often becomes covered with the tiny rafts and their cargoes. They are drifted about by currents or by wind, and sooner or later some of them are certain to be washed against the female flowers, with their protruding stigmas. If so, the pollen, which is exceedingly viscid, is certain to be smeared over the stigmas, and fertilisation consequently effected. Immediately after this takes place the long flower-stalk coils up in a spiral manner, thus drawing the flower under water. The coils gradually become more numerous and more closely packed until at length the flower (or, rather, young seed-vessel) is brought down almost to the muddy bottom of the water. Here the seed-vessel remains until it is ripe, when it opens and discharges the seeds into the water.

The peculiar mode of fertilisation which I have just described is confined to a few species closely allied to *Vallisneria*. The great majority of water-plants produce flowers raised well above the water, whose pollen is carried either by the wind or by insects, as is the case with most plants.

Art. XXXI.—*On some Plants new to the New Zealand Flora.*

By T. F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 5th October, 1896.*]

Haloragis cartilaginea, n. sp.

Stems numerous, stout, erect, 6in.–12in. high, sharply four-angled, usually branched above, rough with minute asperities, but otherwise glabrous. Leaves opposite, often decussate, sessile or very shortly petiolate, broadly ovate or ovate-oblong, ¼in.–¾in. long, acute, coarsely and deeply serrate, very coriaceous, margins thickened and strongly cartilaginous. Flowers small, in many-flowered racemes terminating the branches, clustered, usually drooping. Calyx lobes broadly

triangular, acute. Petals rather longer than the calyx lobes, usually wanting in the female flowers. Stamens 8; styles and ovules 4. Fruit broad at the base, where it is furnished with four short horns or wings, narrowed upwards, conspicuously rugose between the wings.

Hab Cliffs near the North Cape; not uncommon.

I advance this species with considerable hesitation, on account of its close general relationship to the common and variable *H alata* Its differential characters are its smaller size and stouter habit, the shorter and broader leaves, which are highly cartilaginous, and the much more wrinkled and rugose fruit

Coprosma kirkii, n. sp.

A procumbent or prostrate shrub, forming large rounded masses 1ft.–4ft. high and several feet in diameter. Branches numerous, rather stout, often interlaced, younger ones covered with a short and soft greyish-white pubescence. Leaves in opposite pairs, or more usually in opposite fascicles, ½in.–⅞in. long, linear, narrow linear-oblong or narrow linear-obovate, obtuse or subacute, coriaceous, gradually narrowed into a short petiole, flat, midrib usually evident below, lateral veins indistinct Stipules very short, broad, margins ciliate. Flowers on short lateral branchlets. Males not seen. Females in 3–6-flowered fascicles. Calyx lobes 4, minute, equal. Corolla narrow campanulate, 4-fid. Immature drupes oblong.

Hab. North Cape peninsula; Tapotopoto Bay: *T. Kirk!* Near Whangakea, and coast between Tom Bowline's Bay and Hooper's Point: *T F.C.* Near Ahipara: *T.F.C.*

A distinct species, of which my material is unfortunately somewhat imperfect, the male flowers and ripe fruit being unknown. It is allied to *C. cunninghamii* and *C. propinqua*, but differs from both in the smaller size, prostrate habit, pubescent branches, and in the fascicled leaves. From *C. linariifolia* it is at once removed by the absence of the long sheathing stipules which are so conspicuous in that species, and by the much smaller fascicled female flowers. It was originally discovered by Mr. T. Kirk, and I have much pleasure in associating his name with it.

Cassinia amoena, n. sp.

A small round-topped densely-branched shrub, 1ft.–2ft. in height, with much of the habit of an alpine *Veronica* or *Pimelea.* Branches stout, furrowed, younger ones covered with greyish-white tomentum. Leaves close-set, spreading, ¼in.–⅜in. long, linear-spathulate, narrow linear-obovate or linear-oblong, obtuse, gradually narrowed into a short petiole, margins recurved, glabrous above, covered with dense white

tomentum below, midrib not always evident. Heads numerous, in terminal hemispherical corymbs, narrow, ¼in. long, 4–5-flowered; involucral scales pubescent, margins cottony-fimbriate, inner with short spreading white rays.

Hab. Cliffs near the North Cape; abundant.

Differs from *C. leptophylla* in its much smaller size and different habit, larger leaves, narrower heads with much fewer florets, and in the almost total absence of scales among the florets. It is much nearer to *C. vauvilliersii*, some forms of which approach it in habit. It can easily be distinguished, however, by the smaller size, narrower heads, fewer florets, and the absence of scales. The scales are so often completely wanting that the plant might be appropriately placed in the *Ozothamnus* section of *Helichrysum* as *Helichrysum (Ozothamnus) amœnum;* but, as in appearance and habit it is clearly nearer to the New Zealand species of *Cassinia* than to those of *Helichrysum*, I leave it for the present in the former genus.

Geniostoma ligustrifolium, A. Cunn., var. **crassum.**

A small shrub, agreeing in size and mode of growth with the typical state of the species, but differing in the leaves, which are much smaller and broader, ½in.–¾in. long by ⅜in.–⅝in. broad, broadly ovate or orbicular-ovate, subacute, very thick and fleshy in the fresh state. Mature flowers and fruit not seen.

Hab. Cliffs near the North Cape; not common.

The usual form of *G. ligustrifolium* has leaves from 1½in.–2½in. long, membranous or only very slightly fleshy, so that the short, broad, thick, and fleshy leaves of the North Cape plant give it a very distinct appearance. At the same time I feel confident that the differences are only of varietal importance.

An unusually large-leafed variety is abundant on the Three Kings Islands. In it the leaves are from 4in.–6in. long by 2in.–3in. broad, but the texture is the same as in the type. It might be appropriately distinguished as var. *major.*

Veronica insularis, n. sp.

A small erect or decumbent robust shrub, 1ft.–3ft. in height. Branches spreading, stout, covered with transverse scars, pubescent towards the tips. Leaves closely imbricate, suberect or spreading, sessile or nearly so, ¾in.–1in. long, ⅓in.–½in. broad, very coriaceous, oval, oblong or oblong-obovate, acute, rarely mucronate, flat or slightly keeled, opaque, often glaucous, entire, margins thickened, midrib strong. Flowers pale-lilac, in many-flowered corymbs towards the ends of the

branches; bracts large; pedicels rather long. Calyx short and broad; sepals broadly ovate, margins ciliate. Corolla rather large, ¼in. diameter, tube much longer than the calyx. Capsule ovoid, turgid, acute, rather more than twice as long as the calyx.

Hab. Three Kings Islands; rocky places on both the Great King and the Western King, but not common.

Closely allied to *V. elliptica*, and principally differing in the smaller size; broader, darker green, and more coriaceous leaves, which are almost always sessile; in the more truly corymbose inflorescence, larger bracts, smaller flowers, broader shorter calyx, and longer tube to the corolla. In aspect the two plants are very dissimilar, the dwarf habit, dark-green or glaucous leaves, and lilac flowers of *V. insularis* affording a strong contrast to the tall-growing *V. elliptica*, with its pale-green foliage and white flowers.

The genus *Veronica* has such a pre-eminently southern distribution in New Zealand that the discovery of an additional species in the extreme north of the colony is most interesting. It is curious that the nearest ally of *V. insularis* should be a species which attains its maximum development in the islands to the south of New Zealand, and which barely advances northwards half-way along the coast of the South Island.

ART. XXXII.—*An Account of the Plants growing at "The Gums," Taita.*

By T. MASON.

[*Read before the Wellington Philosophical Society, 11th November, 1896.*]

THE grounds and garden at "The Gums," Taita, in the valley of the Hutt, near Wellington, cover an area of about 12½ acres, which was originally part of a dense grove of *Dacrydium totara*, with trees of from 100ft. to 150ft. in height, and from 3ft. to 8ft. in diameter. The outer border is planted with several kinds of *Eucalyptus* (some of which are almost equal in height and diameter to many of the trees that preceded them), *Coniferæ*, and deciduous trees, with an undergrowth, principally of native shrubs, in order to afford protection against the violent gales from the north-west and south-east which frequently sweep up and down the valley. The soil is a rich alluvial deposit of sandy loam, resting on gravel, at a depth varying from 6ft. to 11ft.

The temperature is rarely hot in summer or cold in winter, the highest registered being on 7th February, 1894, when the thermometer rose to 85°, Fahr. in the shade, and the lowest in July of the same year, when it fell to 16° on grass. The thermometer every year rises on three or four days to 80°, and falls about the same number of times to 20°.

The average yearly rainfall during the last nine years is 56in., falling most in winter, but also freely at short intervals during the other months, so that drought is practically unknown. A few of the trees, shrubs, and plants have only been tested one winter; but a large proportion of them were severely tried by a succession of keen frosts on the 5th, 6th, and 7th August, 1875, which destroyed a number of shrubs, among them two kinds of cinchona and several kinds of rhododendron which had withstood the colds of previous winters. Many of the native shrubs suffered severely. No record of the degrees of frost was kept, but, as those which were killed were not replaced, and most of the others have resisted the cold of several winters, the following may be considered as hardy in this locality.

The figures attached to some of the trees and shrubs show their height at the present time; but, as they were planted in different years, as obtained from varying sources, comparisons as to growth cannot be made. Only in one class—the three varieties of *Cedrus*—the relative growth is shown. They were planted at one time—29th April, 1871—and were placed near together, under equal conditions in every respect. They were healthy plants about 15in. high, and have continued healthy and vigorous, and as they grow singly the foliage is dense, and they are clothed down to the ground—fine specimens of their kind.

List of Plants at "The Gums," 1896.

Abelia
- uniflora.
- triflora.

Abies
- alba, 50ft. height, 1896.
- alcoquiana.
- amabilis, 18ft.
- balsamica, 30ft.
- bracteata, 20ft.
- concolor, 9ft.
- douglasii, 35ft.
- firma, 30ft.
- fraseri, 8ft.
- grandis, 6ft.
- hookeriana, 25ft.

Abies
- jezoensis, 9ft.
- lasiocarpa, 8ft.
- menziesii, 20ft.
- montezuma.
- morinda, 40ft.
- nobilis, 18ft.
- nordmanniana, 35ft.
- orientalis, 30ft.
- parsonii, 25ft.
- pattoni, 35ft.
- pectinata, 35ft.
- pindrow, 32ft.
- pinsapo, 30ft.
- rubra, 10ft.

Abies
  tomomi.
  veitchii.
  webbiana, 18ft.
  williamsoni, 30ft.

Abutilon
  aureum.
  Andrew Delaux.
  boule de neige.
  carmineum.
  fleur de neige.
  elegans.
  grandiflorum.
  roseum.
  striatum.
  thompsonii.
  vexillarium.

Acacia
  acicularis.
  alata, 35ft.
  armata, 15ft.
  cultriformis, 8ft.
  decurrens, 12ft.
  dependens, 15ft.
  discolor.
  dealbata.
  darwinii.
  linearis.
  melanoxylon.
  mollissima.
  myrtifolia.
  pycnantha, 15ft.
  saligna.
  suaveoleus.

Acer
  negundo, 18ft.
    variegatum, 15ft.
  palmata.
    atropurpureum.
    palmatifidum.
    ornatum.
    reticulatum.
    sanguineum.
  platanoides.
  pseudo-platanus.
  saccharinum.
  striatum.

Æsculus
  hippocastrum.
    rubicundus.
    flavus.
Acmena
  pendula, 20ft.
  kingiana.
Achuina malvavisca.
Aconitum
  napellus
    albus.
Adenandra uniflora.
Adonis vernalis.
Agapanthus
  umbellatus.
    albiflorus.
Agave
  mexicana.
    variegata.
  densiflora.
Ageratum mexicanum.
Ajuga reptans.
Akebia quinata.
Albizzia julibrizzin.
Albuca nelsoni.
Allium
  moly.
  neapolitanum.
Aloysia citriodora.
Alonsoa warsewiczii.
Alpinia nutans.
Alstromeria
  aurantiaca.
  pelegrina.
    alba.
Alyssum saxatile.
Amaryllis crispa.
Amorpha fruticosa.
Amelanchier canadensis.
Ampelopsis
  quinquefolia.
  bipinnatus.
  veitchii.
Amsonia tabernæmontana.
Anagallis.
Andromeda
  calyculata.
  cassinæfolia.

Andromeda
catesbæi.
cernua.
rubra.
floribunda.
japonica.
phillyreafolia.
polifolia.
racemosa.
Anemone
appenina.
fulgens.
blanda.
nemorosa.
pulsatilla.
sylvestris.
And garden varieties.
Anomatheca cruenta.
Anopteris glaudulosus.
Anona triloba.
Anthericum
liliago.
liliastrum.
Aquilegia
cœrulea.
chrysantha.
skinneri.
vulgaris.
Aralia
papyrifera.
sieboldii.
Araucaria
bidwillii, 35ft.
braziliensis, 20ft.
cookii, 23ft.
cunninghamii, 12ft.
glauca.
excelsa, 50ft.
imbricata, 42ft.
Arbutus
andrachne.
canariense.
unedo.
Arctostaphylos glauca.
Areca
monostachya.
sapida.
Arum
aristatus.
corsicum.
dioscorydes spectabilis.
dracunculum.
hastatum.
orientale.
sanctum.
syriacum.
Arundo
donax.
mauritanica.
Asclepias curassavica.
Aster
novæ angliæ.
belgiæ.
umbellatus.
versicolor.
vimineus.
Athrotaxus cupressoides.
Aucuba japonica.
Azalea
calendulacea.
occidentalis.
vircosa.
indica.
garden varieties.
mollis.
garden varieties.
pontica.
garden varieties.
ghent.
garden varieties.
Azara microphylla.
Babiana
distichiana.
sulphurea.
Baloghia lucida.
Backhousia myrtifolia.
Barleria cristata.
Beckia
lineata.
plicata.
Balfouria pittosporoides.
Bambusa
japonica (4 varieties).
nigra.
Banksia.

Baptisia australis.
Bauera rubiodes.
Bauhinia arborea, 10ft.
Begonia ingramii.
Benthamia fragifera.
Berberis
  aquifolia.
  beallii.
  darwinii.
  fortunei.
  japonica.
  setagi.
  stenophylla.
  vulgaris.
Bessera elegans.
Betula
  alba, 20ft.
    pendula, 30ft.
  lente, 10ft.
  atropurpurea, 12ft.
Bignonia
  capensis
  grandiflora.
  jasminoides.
  mackeni.
  radicans.
    major.
  rosea.
Blandfordia nobilis.
Bobartia aurantiaca.
Bocconia cordifolia.
Bonapartea gracilis
Boronia
  denticulata.
  megastigma.
  pinnata.
Bougainvillea glabra.
Bousingaultia baselloides.
Bouvardia
  flavescens.
  humboldtii corymbiflora.
  jasminiflora.
  triphylla.
Brachychiton
  acerifolium, 10ft.
  bidwillii, 12ft.
Brachysema latifolia.
Brahea filamentosum.
Bravoa geminiflorum.
Brodiæa
  coccinea.
  congesta.
  hendersoni.
Brugmansia
  arborea.
  knightii.
  sanguinea.
Brunsviggia
  alba.
  josephinæ.
  multiflora.
Buddleia
  globosa.
  lindleyana.
  occidentalis.
  paniculata.
Burchellia capensis.
Buxus
  balearicus.
  sempervirens variegata.
  suffruticosus.
Cactus (various).
Calla
  hastata.
  melanoleuca.
Calocassia antiquorum.
Cæsalpinia tara.
Caladium
  esculentum.
    aureum.
Calliandra portoniensis, 15ft.
Callicarpa rosea.
Callitris cupressiformis, 18ft.
Calistemon
  coccineus.
  lanceolatus.
  rigidus.
Calochortus
  albus.
  cœruleus.
  luteus.
  venustus.
Calothamnus sanguineus.
Calycanthus floridus.
Calythrix tetragona.
Camassia esculenta.

Camellia japonica (various).
Campanula
  appenina.
  carpathica.
  grandiflora.
  nobilis.
  persicifolia.
    alba.
    alba plena.
  urticifolia.
Canna
  ehmannii.
  lutea.
  And varieties.
Cantua
  buxifolia.
  dependens.
Carpentaria californica.
Carpinus betulis.
Carrya
  alba, 15ft.
  compressa, 10ft.
  olivæformis, 20ft.
  sulcata, 15ft.
Cassandra calyculata.
Cassia corymbiflora.
Castanea
  vesca, 10ft.
  japonica, 10ft.
Castanospermum australe.
Casuarina
  equisetifolia, 20ft.
  dystila, 15ft.
  quadrivalvis, 15ft.
Catalpa
  bignonioides, 12ft.
  bungei, 15ft.
  syringæfolia, 10ft.
Ceanothus
  americanus.
  divaricatus.
  gloire de Versailles.
Cedrelus australis, 18ft.
Cedrenélla canna.
Cedrus
  atlantica, 50ft.
  deodara, 53ft.
  libani, 35ft.
Celmisia
  lindsayi.
  spectabilis.
Celtis occidentalis.
Cephalotaxus
  fortunei (masc.).
  fortunei (fem.).
Ceratonia siliqua, 12ft.
Cercis
  siliquastrum, 15ft.
    album.
Cerasus
  lusitanicus, 15ft.
  sylvestris.
  serotinus, 20ft.
Cestrum
  aurantiacum.
  diurnum.
Chamepeuce diacantha.
Chamærops
  excelsa.
  fortunei.
  humilis.
Chelone barbata.
Chimonanthus
  fragrans, 12ft.
  grandiflorus, 12ft.
Chionanthus virginicus, 9ft.
Chionodoxa
  alleni.
  gigantea.
  lucilliæ.
Chlidanthus
  fragrans.
  maximus.
Choisya ternata.
Chorozema.
Corydalis
  aureus.
  luteus.
Chrysanthemum (various).
Cinnamomum camphorum, 25ft.
Cistus
  formosus.
  ladaniferus.
  monspeliensis.

Citrus
japonicus, 10ft.
limonus, 15ft.
medicus.
vulgaris.
Clematis
erecta.
flammula.
hexasepela.
coccinea.
graveolens.
indivisa.
lobata.
montana.
pitcheri.
laguninosa.
paniculata
virginiana.
vitalba.
And garden varieties.
Chamæcyparis spheroides
variegata.
Chænestes gesneroides, 15ft.
Clerodendron fragrans.
Clethra arborea, 12ft.
Clivia
miniata.
nobilis.
Coburghia.
Colchicum
album.
autumnale.
autumnale, pl.
atropurpureum.
byzantinum.
parkinsoni.
Colletia bictoniensis
Colutea frutescens
Convallaria
majalis.
rubra.
gigantea.
Cooperia drummondi
Commelina
alba.
celestis.
Coprosma baueriana.
Corchorus
japonicus.
japonicus, fl. pl.
Cordyline
australis.
variegata.
indivisa.
lineata.
Coreopsis auriculata.
Coronilla glauca.
Cornus
florida, 10ft.
serica, 9ft.
Correa
alba
speciosa.
virens.
Corydalis
aureus.
luteus.
Corylopsis spicata.
Corylus heterophyllus.
Coryphra australis.
Cotoneaster
denticulata.
microphylla.
thymifolia.
Crassula
albiflora
coccinea.
Crategus
crus galli, 15ft.
pyracantha, 5ft.
Crinum
americanum.
asiaticum.
Crocus
asturicus
aureus.
biflorus.
Crotolaria lotoides.
Cryptomeria
elegans, 15ft.
japonica, 20ft.
Cunninghamia lanceolata, 30ft.
Cuphea
jorullensis.
platycentra.

Cupressus
  benthami, 20ft.
  cashmeriana, 25ft.
  corneyana, 30ft.
  craigiana, 35ft.
  funebris, 12ft.
  knightii, 40ft.
  lambertiana, 20ft.
  lawsoni, 50ft.
    aurea, 15ft.
    alba spica, 4ft.
    pygmea, 1ft.
    erecta, 15ft.
  macnabiana, 15ft.
  majestica, 10ft.
  torulosa, 45ft.
  udheana, 40ft.
Cussonia spicata.
Cyanella capensis.
Cyathea
  dealbata.
  medullaris.
  smithii.
Cyclamen persicum.
Cypella herbstii.
Cyrtanthus
  mackeni.
  lutescens.
Cytisus laburnum.
Dacrydium
  cupressinum, 20ft.
  franklinii, 15ft.
Dammara australis, 14ft.
Daphne
  mezereum rubrum.
    album.
  indica alba.
  odora rubra.
Daphniphyllum glaucescens.
Dasylirion
  acrotrichum.
  glaucophyllum.
  junceum.
  gracilis.
Delphinium
  cashmerianum.
  formosum.
  nudicaule.
Deringhia amherstii.
Deutzia
  candidissima
  corymbosa.
  crenata, fl. pl.
  gracilis.
  pride of Rochester.
  scabra.
Dicentra
  formosa.
  spectabilis.
Dicksonia squarrosa.
Dictamnus
  fraxinella.
  albus.
Diervillia
  amabilis.
  hortensis.
    niveus.
  rosea.
Diosma ericoides.
Diospyros kaki.
Diplopappus.
Dodecatheon meadia.
Dolichos lignosus.
Doronicum
  plantagineum.
  Harper-Crewe.
Doryanthes
  excelsa.
  guilfoylei.
  palmeri.
Doryphra sassafras.
Dryandra
  serra.
  plumosa.
Duranta
  plumieri.
  alba.
Duvaua dependens, 9ft.
Dyckia leptostachys.
Eccremocarpa scabra.
Echeveria
  coccinea.
  metallica.
Echium candicans.
Edwardsia chrysophylla, 10ft.

Eleagnus longipes.
Eleocarpus cyaneus, 25ft.
Epacris
  grandiflora.
  impressa.
  pulchella.
  tauntoniensis.
  campanulata.
Eranthis hyemalis.
Erica
  alportii.
  alopecuroides.
  arborea.
  baccans.
  calycina.
  carnea.
  ciliaris.
  cavendishii.
  cerinthoides.
    coronata.
  charsleyana.
  colorans.
  cruenta.
    purpurea.
  eweriana superba.
  gracilis.
  grandinosa.
  hyemalis.
  hybrida.
  imbricata.
  linneoides.
  mammosa.
  melanthera.
  mirabilis.
  mutabilis.
  nicolaris.
  persoluta.
    alba.
  perca.
  rubens.
  suaveoleus.
  tetralix.
  ventricosa coccinea.
    bothwelliana.
    breviflora.
    coruscans.
    magnifica.
    superba.

Erica
  vulgaris.
    alba.
  vagans alba.
Erinus alpinus.
Eriostemon nerifolium.
Erythrina
  bidwillii, 4ft.
  cristagalli, 10ft.
  compacta, 9ft.
Erythronium
  denscanis.
  meadii.
Escallonia
  grandiflora.
  monte vidensis.
  pterocladon.
  rubra.
Eucalyptus
  acmenoides, 15ft.
  acuminatus, 25ft.
  amygdalinus, 60ft.
  calophyllus, 10ft.
  carynocalyx, 12ft.
  citriodorus, 20ft.
  cornuta, 30ft.
  ficifolia, 15ft.
  globulus, 120ft.
  gunnii, 80ft.
  goniocalyx, 20ft.
  hæmastoma, 18ft.
  hirsuta.
  leucoxylon roseus, 10ft.
  melanoxylon, 20ft.
  meliodora, 15ft.
  microcyrs, 10ft.
  obliqua, 20ft.
  paniculata, 10ft.
  pilularis, 20ft.
  piperita, 30ft.
  redunca, 25ft.
  resinæfera.
  urnigera, 50ft.
Eucomis
  punctata.
  undulata.
Eugenia ugni.

Eulalia
  japonica.
  albo lineata.
  zebrina.
Euonymus
  japonicus.
  aureo marginata.
Eupatorium riparium.
Eurya latifolia var.
Eurybia australis.
Exochorda grandiflora
Fabiana imbricata.
Fagus
  cunninghamii.
  purpurea.
  sylvatica.
Felicia angustifolia.
Ferraria angustifolia.
Ficus
  glaucus, 15ft.
  macrophylla, 18ft.
Fitzroya patagonica, 20ft.
Forsythia viridissima, 10ft.
Francoa
  appendiculata.
  ramosa.
Fraxinus
  excelsior, 35ft.
    aureus, 15ft.
    pendulus, 9ft.
  smyrniensis, 25ft.
Freesia
  leichtlinii.
  refracta alba.
Freemontia californica.
Frittillaria
  aurea.
  imperialis.
  meleagris.
    alba.
  pyrenaica.
Fuchsia
  boliviana.
  corymbiflora alba.
    rubra.
  excorticata.
  fulgens.

Fuchsia
  triphylla.
  And garden varieties.
Fourcroya gigantea.
Funkia
  ovata.
    marginata.
  subcordata.
  undulata.
Gaillardia
  speciosa.
  pulchella.
Galanthus
  elwesii.
  imperati.
  nivalis.
  plicatus.
Galega orientalis.
Galtonia candicans.
Garrya
  elliptica, 10ft.
  macfadeana, 12f.
Gaultheria
  hispida.
  antipoda.
  shallon.
Gazania ringens.
Geissorhiza ciliaris.
Gentiana acaulis.
Geum coccineum.
Ginko biloba, 30ft.
  Syn. Salisburia adiantifolia.
Gladiolus
  colvillei alba.
  byzantinum.
  And garden varieties.
Gleditchia triacanthos.
Gloriosa superba.
Glycyrhiza glabra.
Goldfussia anisophylla.
Goodia latifolia.
Grevillia
  acanthifolia.
  fosteri.
  heterophylla.
  hilliana.
  latrobei.
  robusta.

Grewia occidentalis.
Greya sutherlandi.
Griselinia lucida, 10ft.
Gymnocladus canadensis, 10ft.
Gynerium
  argenteum.
  purpureum.
Gypsophylla paniculata.
Habranthus
  fulgens.
  pratensis roseus.
Habrothamnus
  elegans.
  newelli.
Hæmanthus
  albiflos.
  coccineus.
  katherinæ.
Hakea
  acicularis, 8ft.
  denticulata.
  eucalyptoides, 5ft.
  saligna, 15ft.
Halesia tetraptera, 9ft.
Hamamelis japonica
Hardenbergia
  comptoniana.
  digitata.
  alba.
Hedera
  helix
  helix, fol. var.
Hedychium speciosum.
Helianthus
  grandiflorus.
  multiflorus.
    plenus.
  perenne.
Heliotropium peruvianum.
Helleborus
  altifolius.
  caucasicus.
  colchicus.
  fœtidus.
  ilicifolius.
  niger.
    angustifolius.
  olympicus.
Hemerocallis fulva.
Hemitelia smithii.
Hepatica
  angulosa.
  triloba.
Hespera matronalis.
Heuchera
  hispida.
  sanguinea.
Hippeastrum (garden varieties).
Homeria aurantiacum.
Hyacinthus
  amethystinus.
  garden varieties.
Hydrangea
  hortensis.
  cerulea.
  cyonocladon.
  Dr. Hogg.
  otaksa.
  rosea alba.
  stellata
    prolifera.
    fimbriata.
  paniculata.
Hymenocallis carribæana.
Hypericum.
Hypoxis
  elegans.
  stellata.
  viscosa.
Iberis semperflorens
Ilex
  cornutum, 9ft.
  aquifolium, 30ft.
    albo-pictum, 9ft.
    aureo-marginatum, 10ft.
Ilicium
  anisetum, 12ft.
  grandiflorum, 1ft.
Indigofera
  australis.
  decora.
Inga pulcherrima.
Inula
  ensifolia.
  grandiflora.

Ipomæa.
Iris
- germanica (various).
- kœmferi (various).
- xiphium (various).
- oncocyclus (various).
- alata.
- atrofusca.
- atropurpureum.
- bismarkiana.
- danfordiæ.
- fœtida.
- grant-duffi.
- histrio.
- histrioides.
- juncea.
- krelagei.
- mariæ helenæ.
- orchioides.
- palestinæ.
- persica.
- reticulata.
  - cœrulea.
- rosenbachiana.
- tingitana.
- sari nazarenæ.
- vartani.

Ismene calathina.
Ixia (various).
Ixiolirion montanum.
Jacaranda mimosæfolia, 12ft.
Jacobæa formosissima.
Jacobinia gheisbrightiana.
Jasminum
- gracile
- grandiflorum.
- nudiflorum.
- officinale.
- pubigerum.

Jubæa spectabilis.
Juglans
- regia.
- japonica.

Juniperus
- bermudiana, 15ft.
- communis, 10ft.
- excelsa, 12ft.

Juniperus
- hibernica.
  - erecta.
- nanus.
- prostrata.
- recurva, 10ft.
- veitchiana.
- virginiana, 12ft.

Justicia
- adhotoda.
- carnea.
- coccinea.

Kalmia
- latifolia
- myrtifolia.
- pumila.

Kennedya rubicunda.
Kentia australis.
Kniphophia
- caulescens.
- macowani.

Koelreutera paniculata.
Laburnum vulgare.
Lachenalia
- aurea.
- nelsoni.
- pendula.
- punctata.

Lagerstræmia indica, 10ft.
Lagunaria pattersoni, 12ft.
Lambertia formosa.
Lantana sellowii.
Lapageria rosea.
Larix europeus.
Lasiandra
- floribunda.
- macrantha.

Latania borbonica.
Lathyrus
- perenne alba.
  - rosea.

Laurus nobile.
Lavandula
- dentata.
- spica.
- vera.

Leonurus leonotis.
Leptospermum myrtifolium.

Leucojum
  æstivum.
  pulchellum.
  vernum.
Leycesteria formosa.
Libertia formosa.
Libocedrus
  chilensis, 15ft.
  decurrens, 30ft.
  doniana, 18ft.
Libonia
  floribunda.
  penrhosiensis.
Ligustrum
  coriaceum.
  japonicum.
  ovalifolium.
Lilium
  aurantium.
  auratum.
    platyphyllum.
    rubrum.
    virginale.
  brownii.
  candidum.
  columbianum.
  elegans alutaceum.
  eximium.
  fulgens.
  hansoni.
  humboldtii.
  leichtlinii.
    rubrum.
  lancifolium.
  longifolium.
  martagon.
  maximowiczii.
  neilgherense.
  pardalinum.
  parryi.
  parviflorum.
  pomponium.
  speciosum.
    album.
    rubrum.
  sovitzianianum.
  superbum.

Lilium
  testaceum.
  thompsonianum.
  thunbergianum.
  tigrinum.
    plenum.
  washingtonianum.
Linicarpia laurifolia.
Linum decumbens.
Liquidamber styraciflua, 18ft.
Liriodendron tulipifera, 45ft.
Lithospermum prostratum.
Livistonia olivæformis.
Lobelia
  catesbæi.
  cavanalesiana.
Lomatia
  longifolia, 15ft.
  ferruginea.
  fraxinæfolia, 8ft.
  bidwillii.
  silaifolia, 7ft.
Lonicera
  aurea reticulata.
  periclymenum.
  fragrantissimum.
  confusa.
Lupinus arboreus.
Lychnis
  chalcedonica.
    alba.
    plena.
  flos-cuculi.
  flos-jovis.
  fulgens.
  haageana.
  sieboldii.
  vespertina plena.
  viscaria.
Lycoris
  aurea.
  radiata.
  sanguinea.
  squamigera.
Lythrum alatum.
Macadamia ternifolia, 12ft.
Mackaya bella, 8ft.

Magnolia
  acuminata, 25ft.
  anonifolia, 3ft.
  campbelli, 25ft.
  conspicua (yulan), 15ft.
  compressa.
  cordata, 10ft.
  fuscata, 12ft.
  gracilis, 15ft.
  grandiflorus, 20ft.
  halleana (*syn.* stellata), 8ft.
  hypoleuca.
  kobus.
  longifolia, 12ft.
  lennei, 12ft.
  norbertiana, 15ft.
  obovata, 8ft.
    discolor, 8ft.
    nigra, 4ft.
    purpurea, 8ft.
  parviflora, 3ft.
  pumila, 3ft.
  soulangeana, 15ft.
  superba, 12ft.
  tripetala, 23ft.
  watsoni, 4ft.
Malva concinna.
Mandevillia suaveolens.
Marattia.
Marica.
Maurandya barclayana.
Melia azidarachta, 10ft.
Melantheum junceum.
Melaleuca hypericifolia.
Melianthus major.
Menispermum canadense.
Menziesia
  polyfolia.
    alba.
Mesembryanthemum.
Metrosideros
  tomentosum, 25ft.
  robusta, 20ft.
Michelia champuca.
Milla
  biflora.
  laxa.
Mimulus
  moschatus.
  harrisoni.
Mitraria coccinea.
Monarda didyma.
Montbresia pottsii.
Morea
  iridioides.
  maricoides.
Morphyxia
  lutea.
  rosea.
Morus
  alba.
  nigra.
Muscari
  botryoides.
    album.
  comosum.
  monstrosum.
  monstratum aureum.
  racemosum.
Myrica californica.
Myrtus communis.
Nandina domestica.
Narcissus (various).
Nerine
  corusca.
  flexuosa.
  fothergillii.
  humilis.
  pudica.
  plantii.
Neillia opulafolia.
Nerium
  odorum.
  oleander.
    album.
Nertera depressa.
Nicotiana affinis.
Neirembergia rivularis.
Œnothera
  mexicana.
  taraxifolia.
Olearia
  angustifolia.
  colensoi.

Olearia
nitida.
haastii.
traversii.
Olea
ilicifolia, 15ft.
fragrans, 2ft
americanus, 20ft.
Omphalodes verna
Ornithogallum
aureum.
arabicum.
pyramidale.
umbellatum.
Osmanthus
ilicifolius, 8ft.
variegata, 5ft.
Ourisia
coccinea.
macrocarpa.
Oxycoccus.
Pœonia
herbaceous (various).
mountain (various).
Pancratium
illyricum.
maritimum.
Papaver
orientale.
concolor.
maculatum.
Passiflora
edulis.
cerulea.
Paulownia imperialis, 20ft.
Pennistatum longistylum.
Pernettya mucronata.
Phædranassa chloracea.
Philadelphus
coronarius, 8ft.
gordoniana, 10ft.
grandiflora, 10ft.
keteleeri, 5ft.
plena, 5ft.
mexicana.
Phlomis fruticosus.
Phlox
amœna.
subulata.
nelsoni.
Phœnix reclinata.
Photinia serrulata, 15ft.
Phyllocladus
trichomanoides, 20ft.
alpinus, 5ft.
Philesia buxifolia.
Physalis alkekengi.
Phyteuma campanulata.
Pinus
australis, 3ft.
austriaca, 30ft.
balfouriana, 4ft.
benthamiana, 18ft.
beardsleyi, 20ft.
contorta.
densiflora, 50ft.
fremontii, 10ft.
halepensis, 25ft.
insignis, 120ft.
jeffreyi.
densa, 20ft.
lambertiana, 15ft.
laricio, 70ft.
longifolia, 15ft.
maritima, 50ft.
mitis, 9ft.
mugho, 20ft.
muricata, 80ft.
pallasiana, 65ft.
parryana, 4ft.
pinea.
ponderosa, 20ft.
pumilus.
radiata, 80ft.
rigida, 45ft.
sabiniana, 90ft.
torreyana, 20ft.
tuberculata, 40ft.
Pisonia sinclairii.
Pithecolobium australis, 8ft.
Pittosporum
buchanani, 10ft.
colensoi, 12ft.

Pittosporum
  crassifolium, 15ft.
  eugenioides, 20ft.
  nigrescens, 15ft.
  tobira, 2ft.
Piptanthus laburnifolius, 6ft.
Plagianthus lyalli, 6ft.
Platanus
  acerifolius, 10ft.
  macrophylla, 8ft.
  occidentalis, 9ft.
  orientalis, 10ft.
Platycodon
  grandiflorum.
    mariesii.
Plectranthus eckloni.
Pleroma sarmentosa.
Plumbago
  capensis.
  larpente.
Podalyria
  styracifolia, 8ft.
  gillesii.
Polyanthus tuberosa.
Polygala
  grandiflora.
  oppositifolia.
Pomaderris.
Populus
  fastigata, 50ft.
  alba, 15ft.
  tremula.
Polygonatum multiflorum.
Primula
  acaulis.
  amœna.
  auriculata.
  capitata.
  cashmeriana.
  cortusoides.
    alba.
  denticulata.
  japonica.
  poissoni.
  verticillata.
  vulgaris.
Pritchardia filamentosa.

Prostanthera
  lasianthos, 10ft.
  rotundifolia, 6ft.
  siberica, 6ft.
Protea mellifera, 4ft.
Prunus
  passardi, 15ft.
  sinensis albus plenus, 3ft.
    roseus plenus, 3ft.
Psidium cattleyanum.
Pterostyrax corymbiflorum, 6ft.
Puschkinia sicula.
Pyrethrum.
Pyrus
  aria, 9ft.
  aucuparia, 10ft.
  japonica, 3ft.
  maulei, 2ft.
  spectabilis, 10ft.
Quercus
  ægilops, 18ft.
  ballota, 12ft.
  coccineus, 10ft.
  cerris, 15ft.
  ilex, 12ft.
  lusitanicus, 35ft.
  macrophylla, 30ft.
  pedunculata, 50ft.
  serratifolius, 20ft.
  suber, 35ft.
  tonzii, 18ft.
  palustris, 18ft.
  virens, 15ft.
  Chilian deciduous, unnamed.
  3 kinds evergreen, unnamed,
    from Japan.
Retinospora
  ericoides, 15ft.
  filifera, 11ft.
  keteleeri, 8ft.
  leptoclada, 16ft.
  obtusa, 15ft.
    aurea, 15ft.
  pisifera, 25ft.
  plumosa, 5ft.
    aurea, 3ft.
  squarrosa, 12ft.
  sieboldii, 4ft.

Raphiolepis
  indica.
  ovata.
Rhamnus
  alaternus.
    variegata.
Rhododendron
  altaclerense.
  arboreum.
    purpureum
  argenteum.
    grande.
  assamicum.
  aucklandii.
  barbatum.
  californicum.
  calophyllum splendens.
  camelliæflorum.
  caucasicum album.
    roseum.
  cinnabarinum.
  ciliatum.
  dalhousii.
    pulchellum.
    roseum.
  dennisoni.
  edgworthii.
  formosum.
  maddeni.
  metternichi.
  nilagericum.
  nobleanum.
  pulchellum.
  præcox.
  sesterianum.
  veitchianum.
  thibaudiense.
  ponticum
    And many varieties.
Rhododendron
  aureum blandum.
    cupreum.
    divaricatum.
    expansum.
    flavum.
    luteum splendens.
    magnificum.
    macranthum flavum.

Rhododendron
    punctatum.
    victoria regina.
    splendens.
Rhyncospermum jasminoides.
Rhodotypus kerrioides, 5ft.
Rhus
  cotinus.
  laciniatus, 3ft.
  typhinus, 4ft.
Ribes
  flavum.
  sanguineum.
Richardia
  ethiopica.
  maculata.
Romneya coulteri.
Rosa (various).
Rubus idæus.
Rulingia parviflora.
Ruscus aculeatus.
Salix
  alba.
  babylonica.
    pendula.
  kilmarnock.
Salvia argentea
  augustifolia.
  bethelli.
  fulgens.
  patens.
  pitcheri.
  verschafeltii.
Sambucus albus.
Sassafras officinale, 5ft.
Saxe-Gothea conspicua, 5ft.
Saxifraga
  crassifolia.
  decipiens.
  geum.
  latifolia.
  umbrosa.
  hirta.
Scabiosa caucasica.
Schinus molle, 10ft.
Scilla amœna.
    siberica.
  amethystina.

Scilla
  bifolia.
    alba.
  campanulata compacta.
    grandiflora.
  peruviana.
    alba
    clusii.
  umbellata.
  taurica.
    alba.
Scutellaria oblonga.
Sciadopytis verticillata, 10ft.
Seaforthia elegans, 5ft.
Sedum dasyphyllum.
Senecio
  buchanani.
  compacta.
  greyi.
  robusta.
  hectori.
Sequoia
  sempervirens, 50ft.
  gigantea, 65ft.
Silene
  cuacasica.
  maritima.
Solandra grandiflora.
Solanum capicastrum.
Sollya heterophylla.
Sophora japonica, 18ft.
Sparaxis (varieties).
Sparmannia africana.
Spiræa (herbaceous)
  aruncus.
  astilboides.
  filipendula
    plena.
  japonica.
  elegans.
  gigantea.
  palmata.
  ulmaria.
Spiræa (shrubby)
  bella.
  blumei.
  californica.
  callosa.
Spiræa (shrubby)
  douglasii.
  fortunei.
  gracilis.
  lindleyana.
  ovata.
  paniculata.
  prunifolia.
  reevesiana.
  salicifolia.
  sorbifolia.
Spreckelia formosissima.
Stachyurus præcox.
Staphylea colchici.
Statice
  macrophylla.
  purpurea.
Stenocarpus sinuatus.
Sternbergia clusiana.
Stokesia cyanea.
Strelitzia angustifolia.
Stuartia pseudo-camellia.
Styrax
  japonica, 12ft.
  officinale.
  obassia, 3ft.
Swainsonia
  galegifolia.
  greyana.
  osbornei.
Syringa
  persica
    alba.
  vulgaris
    alba.
    plena.
  japonica.
Tanaceta balsamica.
Tabernæmontana.
Tacsonia
  manicata.
  mollissima.
Tamarix gallica.
Taxodium distychum, 75ft.
Tecoma
  radicans.
    major.
  australis

Tecoma
  capensis.
  grandiflorus.
  jasminoides.
  rosea.
Telopea speciosissimus.
Templetonia retusa.
Thea
  bohea, 6ft.
  assamica, 8ft.
Thunbergia
  alata.
  hartwiggi.
Thuja
  gigantea, 35ft.
  occidentalis, 15ft.
  orientalis, 10ft.
  tartarica, 8ft.
Tilia americana, 15ft.
Thujopsis
  borealis, 30ft.
  dolobrata, 15ft.
    variegata, 15ft.
  lætevirens, 6ft.
  standishii, 4ft.
Tiarella cordifolia.
Tigredia
  conchiflora.
  grandiflora alba.
  pavonia.
Toxicophlæa spectabilis.
Trachelia cerulea.
Tradescantia
  erecta.
  alba.
Tricirtis hirta.
Trillium grandiflorum.
Triteleja
  conspicua.
  uniflora.
Tritonia (various).
Trollius europeus.
Tropæoleum
  tuberosum.
  speciosum.
Tsuga
  brunoniana, 12ft.
  mertensiana, 40ft.
Tulipa
  elegans
  sylvestris.
  clusiana.
  And garden varieties.
Ulmus
  campestris variegatus, 15ft.
  montanus, 20ft.
    camperdownii.
  picturata, 10ft.
  suberosa, 12ft.
Valeriana pyrenaica.
Vallota purpurea.
Velthemia glauca.
Verbena.
Veronica
  australis
    alba.
  amherstii.
  amplexicaulis.
  anomala.
  buxifolia.
  carnosula.
  colensoiviridis.
  cupressoides.
  epacrida.
  formosa.
  greyii.
  hectori.
  hulkeana.
  lævis.
  lobelioides.
  gibbsii.
  loganoides.
  penguifolia.
  pimeleoides.
  tetragona.
  traversii.
Viburnum
  macrocephalum.
  opulus.
  plicatum.
  sieboldii.
  tinus.
  tomentosum.
Vieusseuxia glaucopsis.
Virgillia capensis.

Vitex
  agnus castus.
  littoralis.
Wachendorfia paniculata.
Wahlenbergia saxicola alba.
Watsonia (various.)
Weigelia (*syn.* Durvillea).
Westringia rosmarinæfolia.
Wigandia caraccassana.
Widdringtonia
  cupressoides, 20ft.
  juniperoides, 10ft.
Wistaria
  multijuga.
  magnifica.
  sinensis
    alba.
Xanthorrhea quadrangularis.
Yucca
  aloefolia.
  baccata.
  elata.
  filamentosum.
  gloriosa.
  recurva.
  whippleyi.
Zenobia
  speciosa.
  pulverulenta.
Zephyranthes
  atamasco.
  rosea.
  treatii.

Art. XXXIII.—*Notes on the Occurrence of Kauri-gum in the Kahikatea Forest at Turua.*

By L. J. Bagnall.

[Read before the Auckland Institute, 5th October, 1896.]

Kauri-gum is so intimately associated with kauri forests, or open lands where kauri forests must have once existed, that to find it in one of the oldest existing kahikatea forests seems to me worthy of being placed upon record.

The Turua Forest lies between the Waihou and Piako Rivers, and consists chiefly of kahikatea. A few trees of rimu and matai are occasionally met with, and two or three young kauri-trees, measuring about 30in. in diameter, have been found. The kahikatea-trees are generally large, some of them attaining to 8ft. in diameter, while many measure from 4ft. to 6ft. Captain Cook, who mentions this forest, found kahikatea-trees 19ft. 8in. in circumference, measured 6ft. from the ground. One, which I believe was measured by him in 1777, and which now girths 28ft , has been preserved.

During the very dry summer of 1890 a fire ran through the old bush-workings, as well as a portion of the adjoining land, on which manuka, toetoe, and harakeke were growing. In order to take advantage of the burn, some drains were cut through the burnt country, and while digging the drains the contractor came upon several patches of kauri-gum. This led

to a search being made for more, with the result that up to the present time fully 100 tons of very superior quality gum has been secured. The gum has been obtained in the open country adjoining the forest, as well as in the forest. Roots and portions of the trunks of kauri-trees have been found while searching for gum. The greatest quantities of gum were got in low-lying places and wet holes. As much as half a ton has been taken from a place about 12ft. square. In places it was found near the surface of the ground, but generally it was got at a depth of from 2ft. to 4ft. There were many indications, such as charred pieces of gum and timber, that fires in the long long ago had destroyed both the forest and much of the gum.

Although the Maoris had previously obtained small quantities of gum in the open country, they appear to have been ignorant of its existence there in any quantity, and I think they never thought of looking for it in the kahikatea forest They knew, however, of the remains of kauri-trees; and the block on which the gum was first discovered after the fire, and from which a great quantity was taken, is called "Te Kauri"

It is well known that the kauri grows in dry hilly country I am not aware of its being found anywhere in such low-lying ground as the Turua lands now are This would seem to indicate that this land was once considerably higher than it now is, or kauri in such quantity would not have grown. Captain Hutton, speaking of the Thames, says, "The land in this district at one time sunk to about 10ft. or 12ft lower than now, and subsequently has again risen to its present level."

How long it is since Turua was covered with kauri instead of kahikatea no one can tell, but it must be a very long time, as I estimate that the large kahikatea-trees are not less than a thousand years old.

So far only a small area of the Turua Forest has been prospected for gum. The undergrowth is so dense that it is not possible to search for gum until a fire has been through, and fire will not run in virgin kahikatea bush—in fact, it is only in very dry seasons that it will run through the old workings. It is quite possible, when the bush has been cleared, that the agriculturist may, in digging his drains, find more of this valuable commodity.

Art. XXXIV.—*A Description of some New Indigenous New Zealand Forest Ferns.*

By W. Colenso, F.R.S., F.L.S. (Lond.)

Read before the Hawke's Bay Philosophical Institute, 12th October, 1896.]

Gleichenia, Smith.

1. *G. ciliata*, sp. nov.

Plant erect (rhizome not seen). Stipe 5in.–7in. long, slender, $\frac{1}{10}$in. wide, subterete and obsoletely angled, somewhat concave above, dry, woody, light-brown, smooth. Frond largely flabellate, 8in.–9in. broad, 4in.–6in. long, forked and dichotomous; main branches spreading, each main branch bearing 2–3 branchlets (in all, 5–7 simple ones in each), subcoriaceous, dark red-brown above; branchlets linear-acuminate, 5in. long, 6–8 lines broad, pinnate (or pinnato-pinnatifid cut quite down to rachis), tips very acuminate, narrow, acute. Segments linear, deltoid, 4 lines long; sub 1 line broad at base, opposite and subopposite, acute, margins entire, revolute throughout, glabrous above, glaucous and floccose below; hairs fine, long, entangled, white; veins distinct, pinnate, forked; costa stout, prominent, pale-brown, with large ovate scales on rachis, adpressed, horizontal and lateral, covering segments at base. Scales flat, finely reticulated, red-brown with white margins and much ciliated. Sori biserial, close, on the middle of outer veinlet, 20–25 on a segment; capsules 2–3 together, yellow, flattened on top.

Hab. On east side of Mount Ruapehu, Taupo district; 1895: *Mr. E. W. Andrews.*

Obs. 1. This species differs pretty much from *G. cunninghamii*, Hew., in several characters, as well as in size. A fine and correct drawing of *G. cunninghamii* (made, too, by Fitch), with dissections, is given by Sir W. J. Hooker in his "Sp. Filicum," vol. i., tab. vi., B, that represents the type species discovered by Cunningham in 1838, in the great interior forest leading from Waimate to Kaitaia, of which, from him at the time, I received a specimen, named by him *G. arachnoidea.* In the accompanying description by Hooker he says, "Stipes clothed with large deciduous scales" (well shown in figure), "fronds of a thick coriaceous texture, the apex of the branches not running out into a tail-like point, but pinnatifid to the extremity, segments linear," and (as there shown) "margins not revolute." Sir W. J. Hooker at that time had only received specimens from the extreme north

(from myself, among others). There is also a much larger and coloured drawing, with dissections, of *G. cunninghamii* (also executed by Fitch) given in the "Flora of New Zealand," by Sir J. D. Hooker, which differs (in some respects) from the former figure, particularly in the stipe and frond entirely wanting both bullate scales and woolly hairs (which are such an important character in the type); yet in his description these are prominently mentioned; also, "branches pinnatifid, segments decurrent on the branches, falcate, linear, ⅛in.–⅜in. long, ⅛in.–¼in. broad, plane, &c. Capsules 2–6" (in the figure shown in clusters of 4 and 3). Sir J. D. Hooker's work was published ten years later, and then he states, "North Island, as far south as Queen Charlotte Sound."

II. I have given (*supra*) some of those differential characters of *G. cunninghamii* not found in this species; and I do this for two reasons: (1.) I have never found *G. cunninghamii* (*vera*) in any of my frequent travelling in woods and districts south of the Thames, though I have of species (or vars.) allied to it. Some I sent from time to time (as collected many years ago) to Kew; and I see that Moore, in his "Index Filicum," has noticed them under *G. cunninghamii*, giving my MS. names of *G. intermedia* and *G. venosa;* I had no time then in those days to closely examine them. (2.) I have more lately seen both specimens and drawings (these latter imperfect) of *Gleichenias* collected south of Auckland, and named by the collectors, growers of ferns, and amateurs *G. cunninghamii*, which I believe to be wrongly named, not representing the much larger and peculiarly-marked northern plant.

Davallia, Smith.

1. *D. (Microlepia) pinkneyi*, sp. nov.

Rhizome densely clothed with spreading hairs (also stipe rachis and subrachises, and veins below), hairs straight, subulate, acute, articulate, whitish, clear, shining at nodes. Stipe erect, 7in.–11in. long, slender, dry, deeply channelled, margins pale raised and rounded, pale-brown, dark at base; hairs reddish-brown at base, fugacious and then stipe slightly submuricatulate. Frond deltoid-acuminate, 8in.–9in. long, 5in.–8in. broad at base, glabrous above, pale-yellowish-green, texture membranaceous, bipinnate, main rachis free throughout; pinnæ subovate-oblong acuminate, alternate, distant, sub 20-jugate, horizontal, subfalcate, spreading, lowest pair opposite; tips lobed, subacute, crinite. Pinnules rather distant, alternate, subovate-oblong, obtuse, toothed tridentate, petiolate, dimidiate, lateral margins lobed and toothed above, teeth large subacute, lower margin entire, oblique, slightly decurrent; the upper basal pinnule largest, 1in.

long, ⅛in. wide, pinnatifid-pinnate at base. Veins numerous, clear, prominent, pinnate, forked, regular not extending to margin. Sori few, 4–8 to a pinnule, distant, intramarginal on tip of veinlet at or near base of serrature, opposite in 4 pairs on the larger pinnules. Involucre very small scale-like, thin, greenish, hairy, margin entire ciliolate. Capsules produced, red.

Hab. In a dry wood near margin of Mangatera Stream, south of Dannevirke; 1895: *Mr. Pinkney.*

Obs. I. A species allied in some respects, though not closely, to *D* (*Microlepia*) *ciliata*, Hook., and to *D.* (*Microlepia*) *strigosa*, Sw. (*D. khasiyana*, Hook.).

II. I look upon the finding of this fern as a special acquisition to our known New Zealand ferns, seeing we had only one species * of this large genus described. It has also a little history, worth briefly relating, as encouragement towards the detecting of other new forms in our little-known woods. A few years ago Mr. Pinkney (a member of the Hawke's Bay Philosophical Institute) told me, that he had a fern from the bush growing in his private fernery which he did not know, it being barren, yet supposed it might be *Asplenium umbrosum.* At my request he, shortly after, kindly brought me a barren frond, and I found, on close examination, it was not *Asplenium umbrosum*, neither was it known to me; so we waited, in hopes of a fertile frond being produced; there were at that time several barren fronds on the plant. Last year (1895) a fertile frond was developed, which, when full grown, Mr. Pinkney also kindly gave me for examination. He had previously revisited the spot where he had found it (and so did I), but the wood had been lately felled and burnt. Curiously enough, I found in my "Synopsis Filicum," at the place containing the sub-genus *Microlepia*, the terminal portion (one-third or one-fourth) of a fertile frond (or pinna) of, apparently, this same species of fern, which I must have laid there some years ago; but I have no recollection as to where or when I got it. Last month I sent one-half of my fertile frond and two barren ones to Kew.

Aspidium, Swartz.

1. *A.* (*Polystichum*) *perelegans*, sp. nov.

Caudex coalescent, stout, 8in.–12in. high, 3in. broad, bearing 10–12 fronds. Stipe 12in.–13in. long, very stout, 3–4 lines diameter, dry hard channelled, scales very numerous

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* I am aware, from "Appendix Synopsis Filicum," of a second species of *Davallia* (*D. forsteri*, Carruth.) having been discovered in New Zealand by Forster, during Cook's second voyage, at Dusky Bay, in the extreme south, but not detected since.

(also on rachis and subrachises). Frond erect, slightly drooping and spreading, 2ft. 3in.–2ft. 6in. long, 7in.–9in. wide at middle, sublinear-lanceolate, base abruptly truncate, tip narrow, very acuminate; bipinnate, bright-green above, paler below, glabrous, flaccid, fresh, chartaceous when dry; pinnæ horizontal, alternate and subopposite above, very close but not imbricate, sublinear-lanceolate, base truncate, 4in.–5in. long, 9–12 lines wide at middle of frond; tips sharply acuminate, subcaudate, finely serrate, 5–6 pairs below opposite and gradually decreasing in size and falcate, the lower 2–4 pairs much deflexed. Pinnules numerous (17–18 jugate), patent very regular, petiolate, alternate, free rather distant, striate when dry, subrhombic-triangular, sometimes subtrapeziform, and again in other fronds somewhat parallelogrammatic, but always truncate at lower base excised dimidiate, sharply and closely serrate above and below on two principal sides; tips produced sharply acuminate aristate; margins thickened darker green and slightly incurved; the lowest pair of pinnules on pinna much larger, pinnatifid, 6–7-lobed, reclining on rachis and meeting above on upper side concealing it, the lowest pinnule largest, pinnate or trifoliolate; veins pinnate. Sori very small, distant, biserial, usually six on a pinnule, sometimes seven on the larger ones but rarely, situate on middle of inner veinlet nearer costa than margin, on a small dark oval half-punctured tubercle in pinnule; involucre small, bright-brown, orbicular, laciniate, much stipitate and soon possessing an everted obconical shape resembling an umbrella blown inside out. Scales of various shapes and sizes: (1) Large, 1in.–1¼in. long, 1 line wide at base, subulate, tip much acuminate and filiform, glossy, striate, curly, with a rich dark brown-black centre and broad pale margins; margin entire and minutely crisped; (2) smaller, thinner, subulate, ½in.–¾in. long, light-brown; (3) filiform, hair-like, reddish, with large branched spreading root-like bases.

Hab. Forests south-west from Dannevirke; 1896: *W. C.*

Obs. This handsome fern is allied to our well-known New Zealand fern *Aspidium aculeatum*, Sw., var. *vestitum*, Hooker; but I believe (after a prolonged and careful examination) differs from that fern—and from others also, its near allies, *A. aculeatum*, *A. lobatum*, *A. intermedium*, and *A. angulare*—in several characters. I possess first-class botanical drawings of all of them, with descriptions, in Hooker's "British Ferns." A particularly fine plate of *Aspidium aculeatum*, with dissections, is also given in Beddome's "Ferns of South India," tab. 121. In *Aspidium aculeatum* the pinnæ want the lowest pinnule below on costa (and so in all its allies, *supra*, including var. *vestitum* of Hooker), which

in this fern always form a prominent pair with the upper pinnule, and is also the largest, being 6–7-lobed, and overlapping rachis; all its pinnules also are much more stipitate and distant. Beddome says of the pinnules of *A. aculeatum*, "Subpetiolate or decurrent at the very base with the adjacent ones" (*l.c.*, p. 429); moreover, the sori on *A. aculeatum* are usually eight on a pinnule, and their involucres larger; the hairs on upper rachis and subrachises simple, very short, and patent, without scales, and the scales on the stipe are also widely different, broader and shorter and of one form only. Sir W. J. Hooker says of *A. aculeatum* and its varieties, "Segments superior, base larger and more or less auricled" (*l.c.*, *passim*). Hooker *fil.* also says of *A.* (*P.*) *aculeatum*, var. *vestitum*, "Segments lower, outer margin auricled" (Flora N.Z., vol. ii., p. 38), well shown in their respective drawings; and again, "The lower outer margin produced into a short broad blunt auricle" (Flor. Tasm., vol. ii., p. 148)—a family feature common to all varieties *supra;* which character, however, is wholly wanting in this fern.

2. *A.* (*Polystichum*) *zerophyllum*, sp. nov.

Plant suberect and drooping; caudex coalescent from old stipites. Stipe 15in. long, slender, woody, dry, deeply sulcated on upper surface (rachis also to tip), pale-straw-coloured above (with rachis), red-brown at base, paleaceous, roughish with minute brownish tubercles from fallen hairs and scales. Frond oblong-lanceolate, 14in.–17in. long, 7in.–8½in. wide at middle; tip subacuminate acute; base truncate; bipinnate, glabrous, subcoriaceous, harsh; dull light-green above, paler below (when dried); rachis and subrachises paleaceous and hairy. Pinnæ alternate distant petiolate oblong-lanceolate, 3½in.–4in. long, 1¼in.–1½in. wide at middle, acuminate; tips narrow, very acute, broadest at bases, patent and slightly subfalcate; costa very slender. Pinnules distant alternate petiolate, 10–11-jugate, ovate-acuminate, ⅜in. long, coarsely and sharply serrate above, tip aristate, semi-lobed and produced at base on the upper side rounded, margin entire; the base at lower side excised; the basal pair opposite much larger, 1in. long, their sides more regular and subpinnatifid, the upper one overlapping rachis above. Veins few, pinnate in pinnule, simple, distant. Sori rather large, distant on middle veinlet, biserial, usually seven on a pinnule, but on each of the larger basal pair 14–15. Involucre ample 5-angled, light-reddish-brown with a large black centre, reverted in age, subsessile. Scales of two kinds: (1) Long subulate very narrow, dark-brown glossy; tips capillary curved and twisted; (2) smaller light-reddish-brown, thin, weak, crumpled, and hair-like.

Hab. Hilly woods south-west of Dannevirke; 1896: *W. C.*

Obs. I. A species having affinity with *A.* (*Polystichum*) *richardi*, Hook., but differing in several characters, as in larger size and form and different colour, in being bipinnate with pinnæ and pinnules distant larger and much more acuminate, in shape and size of pinnules largely and sharply serrated, particularly basal pair on pinnæ which are subpinnatifid, in its slender pale stipe and rachis, in it not being mealy or subfurfuraceous below, and also wanting those curious ciliated scales beneath on segments.

II. Sir W. J. Hooker says of *A.* (*P.*) *richardi*, "Fronds oblong-ovate, suddenly and finely acuminate, subfurfuraceous beneath with minute subulate scales ciliated at their broad bases; pinnate (scarcely sub-bipinnate), pinnæ 2in.–3in. long, close and compact, deeply pinnatifid nearly to the costa; segments lanceolate, numerous, close-placed, margin entire or obsoletely crenate rather than serrate" ("Sp. Filicum," vol. iv., p. 23). His figure with dissections of the same fern, pl. 222, *l.c.*, are very good. Baker also, in subsequently describing it, adds, "Differs from *A. aculeatum* by its more rigid texture, shorter teeth, and lower pinnæ not reduced" ("Syn. Filicum," p. 253). Sir J. D. Hooker also, in his coloured drawing of *A. richardi* (tab. 78, "Flora of New Zealand")—although the pinnæ of his figure are more distant than those of that one in "Sp. Filicum" (*supra*), and the drawing in "Sp. Filicum" was made *after* that in the "Flora of New Zealand," and more particularly to represent *A. richardi*—nevertheless the pinnules are also sessile, crowded, and scarcely serrate—just as Sir William has them; all which, as we well know, truly represents our New Zealand fern *A.* (*P.*) *richardi* (*vera*); of which species there are also several sub-varieties, in size all more or less closely resembling the type.

Todea, Willdenow.

1. *T. marginata*, sp. nov.

Plant suberect, tufted, sometimes with short caudex composed of coalescent stipites. Stipe 5in.–7in. long (or more), stout, deeply sulcated above, dull dark-green, thickly covered with red-brown matted floccose hairs (also the same, but more slightly on rachis and subrachises below). Frond oblong-lanceolate, 2ft. 5in. long, 9in.–10in. broad at middle, tip acute, base truncate (5in. wide); lower rachis stout as stipe but very slender above, bipinnate, glabrous, dark-green, stoutish-membranaceous. Pinnæ numerous, sub-30-jugate, oblong (or subdeltoid), acuminate, broadest at base, 4½in.–5in. long, 1½in. wide, pinnate, subfalcate, subopposite above, opposite below, somewhat distant, 2in. apart below, decreasing in size from middle downwards. Pinnules oblong, 6–7 lines

long, 3–4 lines wide, pinnate, free, subfalcate, pinnatifid to costa, deeply forked, lobes long, linear, equal, subacute; tips callous; margins entire, thickened, lighter green; the upper basal pinnule three-lobed. Veins simple, thickish, prominent, extending to margin; white strangulated hairs patent on subrachises among red woolly ones. Sporangia throughout numerous, close, compact, covering pinnule; capsules pitted, red-brown, subsessile.

Hab. Forests near Dannevirke; 1888–96: *W. C.*

Obs. This fine fern I had often noticed and admired in my annual visits to the woods, but, without closely examining it, had considered it to be a larger plant of the more common species *T. hymenophylloides*, which also grew plentifully there. However, while in those woods in September of this year (having more spare time), I procured a frond for a closer examination, and I find several characters differing from those of *T. hymenophylloides*. Not only in its much larger size, form, habit, darker colour and texture—all apparent at first sight—does it differ, but in several minute characters given above in its description; as its numerous sporangia thickly covering the pinnules, and their being truly pinnate and free, with thickened and coloured margins and veins; and its pinnæ decreasing in size and very distant on rachis towards base. In the early drawings of the typical specimens of *T. hymenophylloides* these characters do not appear; the forked lobes of the pinnatifid pinnules are shown to be shorter and greatly unequal, with few and scattered sori confined to their bases, while "sporangia sparsa" is given as a character pertaining to it (Hook. et Grev., "Genera Filicum," tab. xlvi., B.); and in Sir W. J. Hooker's faithful drawing ("Icones Plantarum," vol. i, tab. viii.) a portion of the highly-membranous frond is also separately given to "show the reticulated structure of the frond," which I have failed to detect in this fern. Baker also (in "Syn. Filicum," the latest authority) says, "Tripinnatifid, with pinnules cut down nearly to the rachis," adding (in a note), "There is a form which quite agrees with this in the size and cutting of the pinnæ, but which has the lower ones reduced very gradually, thus receding from the type in the direction of the next species" (*T. superba*, Col., *l.c.*, p. 428), which may possibly be this one here now described, though I doubt it. In a fine specimen of *T. hymenophylloides* (*vera*) I have now before me, I find the pinnules on its middle pinnæ to be largely pinnatifid on their costa, with the lobes on their sides nearer the rachis simple and single instead of forked.

Genus: *Unknown.*

Plant large, erect, slightly drooping; stipe 10in.–11in. long, 2–2½ lines thick, rather slender, dry, sulcate and striate

(also rachis to tip), brownish below, pale-straw colour above, hairy; hairs red-brown, shining, copious, short (also on rachis and subrachises, and midrib below), 1in. long, and straight at base. Frond broadly ovate-lanceolate, 22in.–23in. long, 13in. broad at middle, tip acuminate, bipinnate, subcoriaceous, slightly harsh, glabrous, dull-darkish-green above, paler below. Pinnæ oblong-acuminate, broadest at base, gradually decreasing to tip, 6in.–6½in. long, 1in.–1¼in. broad, alternate, distant, petiolate, horizontal, spreading; tips narrow, much acuminate; the ultimate lobes long, serrate, acute; lowest pinnæ deflexed. Pinnules sublinear-oblong, acute, ¾in. long, ¼in. wide, 20–23-jugate, alternate, petiolate, rather distant, falcate, deeply (6–7) lobed or subpinnatifid; lobes nearly as broad as long, somewhat square, each lobe coarsely and sharply serrate, with 4–6 teeth, slightly recurved; midrib stout prominent, whitish above, wavy, free. Veins numerous, pinnate in each lobe, free, reaching to margin.

Hab. Dense forests south-west from Dannevirke; 1896: *W. C.*

Obs. It is wholly against my practice and mind to describe a barren and unknown fern; but this is a very striking and peculiar one. Unfortunately I have not yet succeeded in obtaining it in fruit, but hope to do so on my next visit to these woods this summer. In general appearance it resembles no New Zealand fern known to me, therefore I cannot venture to place it under any of our known genera. It may, however, prove to be a species of *Polystichum* (including *Lastrea*), or a *Dicksonia*, though unlike our known species of those genera.

ART. XXXV.—*Supplement to List of Flowering-plants indigenous to Otago.*

By D. PETRIE, M.A., F.L.S.

[*Read before the Auckland Institute, 3rd August, 1896.*]

THROUGH the kindness of various correspondents my attention has been drawn to a number of accidental omissions from the list of flowering-plants indigenous to Otago which was published in vol. xxviii. of the "Transactions of the New Zealand Institute." I now submit a list of the species omitted, together with corrections of two errors in the identification of species:—

Drosera pygmæa, DC.—Bluff Hill; collected by T. Kirk and B. C. Aston.

Corokia cotoneaster, Raoul.—Not uncommon in the E., S., and C. Dunedin; Otepopo; Kaitangata and up Clutha Valley to head of lakes; Tapanui; Te Anau; Bluff.

Teucridium parvifolium, Hook. f.—Near Oamaru; Otepopo; Bendigo and Queensberry (in gullies); Balclutha. A rare and local plant.

Lemna minor, L.—Common in still, fresh waters.

Triglochin triandrum, Michaux.—Common in wet grounds near the sea.

Triglochin palustre, L.—Near Black's, in a small boggy spot.

Potamogeton polygonifolius, Pourr.—Catlin's; Waipahi.

Potamogeton pectinatus, L.—Lake Waihola, and still waters of Taieri Plain.

Potamogeton ochreatus, Raoul.—Waipahi River.

Potamogeton cheesemanii, Bennett.—Common in most parts of the district.

Cordyline indivisa, Hook. f.—Mr. H. J. Matthews informs me that this is plentiful at Dusky Sound.

Utricularia monanthos, Hook. f., should appear instead of *U. colensoi* on page 571;* and

Epilobium elegans, sp. nov., instead of *E. gracilipes*, T. Kirk, on page 551. My thanks are due to Mr. Kirk for a specimen of his *E. gracilipes*, which has enabled me to detect my mistake in identifying my plant with his.

Art. XXXVI.—*Note on* Gunnera ovata, *Petrie.*

By D. Petrie, M.A., F.L.S.

[*Read before the Auckland Institute, 7th September, 1896.*]

In volume xxvii. of the "Transactions of the New Zealand Institute" (pp. 344, *et seq.*), Mr. T. Kirk, F.L.S., refers my *Gunnera ovata* to *Gunnera flavida*, Colenso, and separates from the former what he takes to be a distinct species, and describes under the name *G. mixta*. I am unable to accept Mr. Kirk's view that my *G. ovata* is identical with Colenso's *G. flavida*. The latter plant is described by the author of the species as having "fleshy drupes," a character that is quite

* Trans. N.Z. Inst., vol. xxviii.

foreign to my species, the drupes of which are hard and almost stony, with no fleshy exocarp or covering of any kind. Before publishing my species I had specimens of it compared, through the kindness of Mr. W. T. Thiselton Dyer, C.M.G., director of the Royal Gardens at Kew, with the types of the New Zealand species preserved in the Kew Herbarium. My plant was reported as new and distinct, and was accordingly published in 1891. It was because the species of *Gunnera* are so imperfectly known and so poorly described in the floras hitherto published that I had this comparison made, and I attached, and still attach, great importance to its results.

As *Gunnera flavida*, Colenso, was evidently in many respects like my species, I again consulted Mr. Thiselton Dyer, who had my specimens carefully compared with Colenso's type of *G. flavida* deposited at Kew, with the result that the species were considered distinct, and that Colenso's species was pronounced identical with *G. prorepens*, Hook f. I entertain no doubt that this view of Colenso's species is correct, and it explains what is otherwise inexplicable, how he described the drupes as fleshy, for that is the character of the drupes in *G. prorepens*.

Mr. Kirk ignores the fact that Mr. Colenso described his plant as having "fleshy drupes," and he altogether omits this most important differential character from his amended description of Mr. Colenso's species It is evident that Mr. Colenso described and sent to Kew one plant, and some years later forwarded a different one to Mr. Kirk; and there seems to be no doubt that the latter is identical with my *G. ovata*. That the original plants of *G. flavida*, Colenso, had "fleshy drupes" is proved by the author's own words; and the proof is confirmed by the fact that his type plant is referred at Kew to *G. prorepens*, Hook. f., a species which also has fleshy drupes. The constant absence of this character in my species securely establishes its independence.

In these circumstances, I must claim that the identification of my *G. ovata* with Mr. Colenso's *G. flavida* is devoid of warrant, and that my plant is quite distinct from the latter, which is no doubt identical with *G. prorepens*, Hook. f.

Though Mr. Kirk has not seen the ample series of flowering and fruiting specimens I had before me when the description of *G. ovata* was drawn up, he implies that I had no specimens showing both leaves and fruit. In this he is mistaken, as I had numerous specimens of this kind, and the description of the leaves, flowers, and fruit as given in my character of the species is strictly correct. The typical specimens were gathered in the neighbourhood of the Hindon

School (Otago), where I have had several opportunities of studying the plant in flower and also in fruit. I can therefore say positively that the leaves and fruit as described by me belong to the same species, and even to the same plants, as many perfect specimens in my possession conclusively show. The statement that "*G. ovata*, as described by Mr. Petrie, consists of two distinct plants" is thus wholly unwarranted. Mr. Kirk no doubt means to say that a number of specimens sent him by me under the name *G. ovata* contained, in his opinion, two distinct plants, which is a very different thing, and may or may not be the fact.

I expressed no opinion as to whether my *G. ovata* was or was not identical with the probable fourth species of *Gunnera*, referred to on page 68 of the "Handbook of the Flora of New Zealand." I merely quoted Mr. N. E. Brown's opinion. I may now, however, say that that botanist's view is not so unlikely as Mr. Kirk supposes, as the leaves of *G. densiflora*, Hook. f., as described in the Handbook, present a close resemblance to those of *G. ovata*. I was not at the time acquainted with *G. densiflora*, and very properly refrained from indorsing, or even remarking on, Mr. Brown's opinion, which has been improperly ascribed to me.

As to *Gunnera mixta*, T. Kirk, the leaves described in my character of *G. ovata* undoubtedly do not belong to it, for the leaves and fruit as described form part of the same actual specimens, and the fruit is acknowledged to belong to a distinct species—namely, my *G. ovata* or Colenso's *G. flavida*, whichever be the correct name for it. Though I have a considerable suite of specimens of the plant distinguished as *G. mixta*, I have not been able to satisfy myself that it is distinct from *G. ovata*. Mr. Kirk's description, owing to imperfect material, is far from accurate. He is not aware that the plant is almost as strictly diœcious as *G. ovata*, and that its inflorescence differs from the latter only in trifling characters. It is, however, difficult to accurately compare the flowers of the species of *Gunnera* except in the fresh state. The fruit, too, of *G. mixta* is not well known, though in my species it differs but little from that of *G. ovata*. But the fruit needs to be examined in the fresh state before the position of the plant can be settled with certainty.

ART. XXXVII.—*Descriptions of New Native Plants.*

By D. PETRIE, M.A., F.L.S.

[*Read before the Auckland Institute, 3rd August, 1896.*]

1. **Epilobium elegans**, sp. nov.

Stems simple or branched from the base, slender, 2in.–5in. high, marked above by two bands of fine crisp pubescence, almost or quite glabrous below, decumbent and rooting at the base, then erect.

Leaves crowded below, the cauline more distant, opposite (except the flowering-bracts) and connate, linear or narrow lanceolate (½in.–¾in. long by ⅛in. broad), obtuse or subacute, sometimes submucronate, shortly and obscurely toothed, thin, light-green, glabrous; midrib evident, sometimes translucent; secondary nerves very obscure.

Flowers few, in the axils of the upper leaves, large, white, shortly pedicelled; petals deeply lobed, about twice the length of the sepals.

Capsules glabrous, reddish-brown, ¾in.–1¼in. long, narrowed at the apex; fruiting peduncles much longer than the flowering, slender, finely pubescent, 2in. long, or less.

Testa of seeds smooth.

Hab. Dunedin; Mount Kyeburn; Naseby; Spear-grass Flat; Mount Torlesse: 300ft.–3,000ft.

In stunted forms the stems are simple, the leaves closely crowded, the flowers solitary, and the peduncles and capsules much shorter than in well-grown forms.

The present species is close to *E confertifolium*, Hook. f. The linear thin leaves, larger flowers, elongating pubescent peduncles, longer brown capsules, and smooth seeds are its chief differential characters.

2. **Hydrocotyle hydrophila**, sp. nov.

A very small species, everywhere perfectly glabrous or with a few slender hairs at the tops of the petioles.

Stems creeping and rooting, very slender, sparingly branched.

Leaves ⅛in. in diameter, 3-partite to the base, thin, with rather long slender petioles; lobes of the leaf obcuneate, rounded at the tip or 2- or 3-crenate.

Peduncles filiform, 1in. long, or less; umbels few-flowered (1 or 2, rarely 3); flowers sessile or subsessile.

Fruit small, glabrous; carpels ⅛in. broad $\frac{1}{16}$in. high, acute at the edges, with one rib on each face.

Hab. Matata (Bay of Plenty); Otago Harbour; Wycliffe Bay; Tomahawk Lagoon; Bluff Harbour; Stewart Island.

I am indebted to Mr. B. C. Aston for a knowledge of several of the foregoing habitats, as well as for fruiting specimens from Wycliffe Bay.

This species is near *H. muscosa*, R. Br., of which I was at first disposed to regard it as a variety. The smaller size of the plant, and especially of the carpels (which are not one-third the size of those of *H. muscosa*), its wide distribution, the constancy of its characters throughout its range, and its restriction to wet seaside stations, seem to me sufficient to establish its specific independence. It has been repeatedly referred to var. *tripartita* of *Pozoa trifoliolata*, Hook. f., but the carpels were then unknown. These leave no doubt as to the genus in which it must be ranked.

3. **Ourisia cockayniana**, sp. nov.

A tufted glabrescent small-leaved alpine species.

Stems creeping and matted, with numerous short branches, rather stout.

Leaves in opposite pairs, not imbricating: radical ¾in. to 1¼in. long; blade short, coriaceous, broadly ovate, obtuse, glabrous, crenate-serrate, the lower surface with strongly-marked anastomosing veins, and mottled with spots and blotches of purple; petioles longer than the blades, broad, flat, fringed at the edges with long ciliate white hairs, and bearing some sparse long hairs on the back.

Scapes simple, leafy, purplish, glabrescent, stout, 4in. to 6in. high. Cauline leaves and bracts in pairs, ovate or ovate-cuneate, subsessile, ciliate along the lower margin, as large as the blades of the radical leaves or larger (½in. long and nearly as broad), not diminishing towards the top.

Flowers in pairs (five or fewer), large, white, on slender glabrous pedicels 1in. to 1¼in. in length. Calyx cut nearly to the base into oblong or slightly cuneate segments, glabrous but for a few ciliate hairs at the base of the lobes. Corolla-lobes broadly obtuse, emarginate. Capsules ⅛in. long, rather more than half the length of the persistent calyx.

Hab. Mount Alexander; Teremakau Valley: 5,000ft.

The present species, which was discovered some years ago by Mr. L. Cockayne, has grown very freely in gardens at Dunedin. It is easily cultivated, and forms a showy plant. Its large bracts easily distinguish it from the other species native to New Zealand.

ART. XXXVIII.—*A Modern Chapter in Vegetable Physiology.*

By D. PETRIE, M.A., F.L.S.

[*Presidential Address to the Auckland Institute, 8th June, 1896.*]

It is now rather more than a hundred years since the foundations of an accurate knowledge of vegetable growth and nutrition were laid. The first important result to be established was that plants derive the whole of their carbon from the carbon-dioxide of the air. And carbon, we must remember, is the most important constituent of plant tissues, forming, as it does, something like half the dry weight of nearly all plants. Not long after this result was established came the proof that the carbon-dioxide of the air is not directly assimilated by plants, but undergoes decomposition in the chlorophyll-bearing cells of the leaves under the influence of sunlight, the carbon going to form part of the food of the plant, while the oxygen combined with it is given back into the air. In course of time it was seen that in the process of fixing this carbon and uniting it with oxygen and hydrogen into carbo-hydrates which finally appear as starch or sugar, large quantities of energy are locked up in the products of the synthesis. The energy thus condensed is wholly derived from the sun's rays; and it is now recognised as the sole source and origin of the activity that animals of every grade display, as well as of the energy locked up in coal, wood, and vegetable oils, which we utilise for doing work in our steam-engines, and for giving heat and light in our factories and homes. The green plant thus appears in the guise of a living storage engine, focussing and accumulating, for the use of man and of the animal creation in general, the energy which the sun unceasingly pours upon our planet. The question of the origin of the carbon contained in plant tissues was thus the first to be clearly and permanently settled. The settlement showed that man can do nothing to hasten or retard the process of carbon assimilation; and, further, that the stores of carbon-dioxide spread through the air are more than sufficient to meet the daily and hourly wants of every green thing that grows on the face of the earth. Nature has spontaneously made the most ample provision for the nutrition of plants so far as carbon is concerned.

While the process of carbon fixation was under discussion speculation began to busy itself with the sources of the nitrogen contained in vegetable tissues. As plants derived their carbon entirely from the air, of which it forms but a minute

fraction in point of bulk, what could be more natural than the supposition that their nitrogen also was derived from the same source? For by this time it was well known that nitrogen gas, in a free or uncombined state, constitutes four-fifths by volume of the air. Observation of the behaviour of growing plants, however, soon made it doubtful if this supposition could be entertained; and in the early years of the present century Theodore de Saussure, a distinguished Swiss *savant*, as the result of numerous experiments, concluded, not without due caution, that plants do not fix and assimilate the free nitrogen of the air, or get any part of their supply from that source.

The question thus raised continued to be debated for many years; but no certain results were gained until the investigation of the points in dispute were undertaken by the justly-celebrated French *savant* Boussingault. In a series of careful and masterly researches carried out between the years 1845 and 1865 Boussingault displayed remarkable ingenuity in devising methods of interrogating nature by simple and decisive experiments, and laid the foundation of the experimental methods of to-day, which will be referred to in some detail in the course of this address. His researches showed conclusively that, under the conditions of his experiments, atmospheric nitrogen is not employed in the process of the assimilation of plants. His experimental plants in every case grew vigorously, and produced a normal amount of proteid compounds when he presented to their roots nitrogenous compounds of various kinds, in addition to the other non-nitrogenous substances necessary for their nutrition. They grew very badly, on the other hand, and their proteid substances did not increase in amount, when this supply of nitrogenous compounds was withheld, although the free nitrogen of the air was at their disposal if they could use it. Thanks to the now much further developed art of nourishing plants artificially, and especially by means of water cultures, we are to-day in a position, by means of simple experiments, to afford ocular demonstration of the important results obtained by Boussingault. Whenever a sufficient quantity of saltpetre is added to the nutritive solution the experimental plants grow vigorously, produce numerous ripe seeds capable of germination, and give on analysis a corresponding increase in the nitrogenous substances they contain. On the other hand, if the nitrate is withheld from the nutritive mixture, the experimental plant grows for a time, it is true, making use of the proteid substances already contained in the seed for the formation of the protoplasm of its cell and organs; and this stunted growth may even continue for some time, since the protoplasm of the first leaves is again dissolved and absorbed

from them to be employed in the formation of new leaves; but eventually analysis of the mature plant shows no increase of proteid or nitrogenous substance, and but little increase in total weight, when compared with the seed from which it has grown.

Soon after Boussingault's results were communicated to the scientific world, Lawes, Gilbert, and Pugh, the great English authorities on agricultural research, undertook at their well-known experimental farm at Rothamstead a fresh investigation of this question among others. Their results entirely confirmed Boussingault's conclusion that plants do not directly fix and assimilate the free nitrogen of the air, but derive the whole of their supplies of nitrogen from nitrates and other nitrogenous compounds in the soil, presented to their roots in a state of solution. As a result of later researches, Lawes, Gilbert, and Pugh drew attention to a very remarkable fact about the leguminous plants which they had investigated. In the case of most crops the nitrogen which they were found on analysis to contain could be entirely accounted for by the combined nitrogen originally contained in the soil, as shown by analysis of samples, or added to it in the form of manure, or washed down from the air by rain. But in particular leguminous crops, such as peas, beans, vetches, lupins, and the like, the crop contained more nitrogen than could be accounted for from the known sources of supply. Here was a thoroughly established fact that could not be explained by any of the recognised canons of the vegetable physiology of the time. The excess of nitrogen fixed by these leguminous plants was for the time being a mystery that no one could solve. The accuracy of the observations and analyses were in due season confirmed by other inquirers, but no clue to the explanation of the unaccountable excess of nitrogen accumulated in these plants could be so much as suggested.

The fact that leguminous plants contain more combined nitrogen than could have been drawn from the known sources of supply in the soil and air was at once seen to be in harmony with the experience of agriculture in ancient as well as in modern times. Even the Romans had believed that leguminous crops grown on impoverished land greatly improved its fertility, and it was a commonplace of agricultural practice that cereals and grass crops grew much better after a crop of pulse than after any other.

Inquiry into the source of the excess of nitrogen fixed by leguminous plants was at once taken up, and all sorts of opinions were formed and given to the world. But there was no agreement or approach to agreement among inquirers. More than twenty years had to pass by before any real light

was thrown on the question. Some two hundred years ago Malpighi, an Italian *savant*, drew attention to certain nodules or tubercles that grow on the roots of leguminous plants; and at a later time Linnæus described these nodules on the roots of *Lathyrus* (the sweet-pea). From this time the nodules continued to attract the occasional notice of botanists, but nothing of importance was learned about them for many years. In 1856 Lachmann investigated their minute structure, and much discussion ensued, but with no real understanding of the facts. In 1866 Woronin made the important discovery that the root-tubercles contained great numbers of minute organisms, since named "bacteroids"—*i.e.*, bacterium-like bodies. Things were thus getting into train for a true comprehension of the *rôle* played by the root-tubercles in the nutrition of leguminous plants; but ten more years had to elapse before the connection between the activity of the root-tubercles with the associated bacteroids on the one hand, and the abnormal fixation of nitrogen by leguminous plants on the other, was conceived and investigated.

In November, 1886, two German investigators, Professor Hellriegel and Dr. Wilfarth, who had been engaged for a considerable time on a wide and fruitful investigation of the nitrogenous nutrition of gramineous, leguminous, and other agricultural plants, published their first important results. To these I shall refer at some length, not only on account of their intrinsic importance, but also because they afford excellent examples of scientific method, of skilfully-directed interrogation of nature, and of the cautious and logical interpretation of experimental results.

To ascertain the sources of the nitrogenous food of plants these inquirers sowed and raised a variety of gramineous plants (including cereals and grasses) in a soil deprived of nitrogen and protected from rain, but to which all other mineral substances necessary for the healthy nutrition of plants had been added in proper quantities. The seedlings developed normally until the third leaf appeared, when the reserves of food contained in the seeds were exhausted. At this point growth ceased suddenly. The plants did not die; they lived almost as long as normal plants, but their vegetation was dwarfed. The stunted plants developed stunted and miserable organs, even barren ears, and struggled through the season. Their total dry weight was found to have increased very little beyond that of the seed, and the increase was of non-nitrogenous substances only. When nitrates were added to the soils as soon as the arrest of growth set in, normal growth was soon resumed, and if sufficient nitrates were added it continued without check to full maturity. If, on the other hand, the nitrates were insufficient, a gradual passage to the

starved condition supervened. In those experiments it was found that, within the limits of the optimum supply, there was a direct proportion between the amount of nitrates added and the yield of grain.

If, instead of nitrates, ammonia salts or other nitrogenous compounds were added the resumption of growth was delayed; and only after a pause of considerable length did these salts become available as nutriment. In this case the increase in the yield of grain was not proportional to the amount of ammonia added.

These results threw considerable light on a question that had been much debated. Justus von Liebig and others taught that ammonia and salts of ammonia were the most desirable form in which plants could receive their supplies of nitrogen. Hellriegel's results make this view extremely doubtful. The evidence irresistibly suggests that the salts of ammonia had to undergo nitrification—*i.e.*, had to be oxidized into nitrates—before the roots of the grasses could avail themselves of their stores of combined nitrogen. As this has little direct bearing on my immediate subject, I need only say that Hellriegel considers that nitric acid and its salts are the only directly available sources of nitrogen for gramineous plants. The main result of this series of experiments was the proof that the Gramineæ are entirely dependent on the combined nitrogen in the soil for their supplies of nitrogen. They cannot draw upon the stores of free nitrogen in the air, except in so far as rain or dew carry down nitrogenous compounds into the soil.

Hellriegel then proceeds to show that similar experiments with leguminous plants yield totally different results. In a soil devoid of nitrogen and protected from rain, exactly like that in which the gramineous plants had uniformly starved, peas were allowed to germinate and grow; and in nearly every case they flourished and yielded a large increase. Thus peas grown in small culture-vessels little larger than a thimble yielded above ground between two and three times the amount of dry substance that the seeds contained, and this, of course, without any addition of nitrates to the soil in which they grew. The plants grew normally throughout, and even vigorously. Hellriegel notes that such a yield of dry substance from the same kind and quantity of soil could not have been obtained with a gramineous plant such as barley, even with the addition of a sufficiency of nitrates. The result which Lawes, Gilbert, and Pugh had reached by analysis of leguminous plants—namely, that these plants absorb and utilise much more nitrogen than the soil can supply—was placed once for all on a firm basis of trustworthy experiment.

The source of the nitrogen gained by these pea-plants had now to be considered. The soil contained none, for it con-

sisted of pure quartz sand repeatedly washed, and was enriched by a nutritive mixture that contained no nitrogenous compound. The water used was specially prepared, and free from ammonia and nitric acid. Moreover, the starvation of the grasses grown under the same conditions proved the absence of nitrogen compounds in the soil. It was thus quite clear that the soil was not the source of supply of the accumulated nitrogen of the leguminous plants

The only other possible source of supply is the nitrogen in the atmosphere. Now, nitrogen exists in the air in two distinct forms—(1) As free nitrogen, which forms by far the largest part of the air; and (2) as combined nitrogen in the forms of nitric acid and salts of ammonia (carbonate and nitrate). Hence we must assume either that leguminous plants have an extraordinary capacity for collecting and absorbing by their leaves the very scanty nitrogen compounds in the air, or that they somehow make use of the abundant stores of free nitrogen which it contains.

The following considerations led Hellriegel to favour the latter of these hypotheses: When peas are cultivated in a soil free from nitrogen, and under the conditions described above, two remarkably sharp periods of growth are to be noticed. So long as the reserves of food stored in the seeds last, the seedlings grow naturally, luxuriantly, and with the normal colour. As soon as the reserves are exhausted, a somewhat sudden change occurs—growth stops, the leaves turn pale, and the plant evidently begins to starve. Sooner or later, however, the pale or yellow leaves again turn green, and a second period of active growth sets in, after which the plants grow normally to the end. When the arrest of growth sets in each plant has about six leaves; and, if these can fix and assimilate the nitrogen compounds in the air, we are quite unable to understand why the starvation phase should appear at all. If the leaves cannot perform this function when in vigorous growth and of normal green colour, how can we suppose that they begin to do so when in a sickly and discoloured condition? Hellriegel was not, however, satisfied with these general considerations, but proceeded to carry out a series of new experiments that would enable him to decide with certainty between the rival hypotheses.

Four vessels were filled with soil devoid of nitrogen, and peas were put in and allowed to germinate. The vessels were then placed under four bell-jars completely closed, except where they were joined by connecting tubes. The four vessels were arranged in series, so that a constant stream of air was drawn through from No. 1 to No. 4. Absorption vessels were placed between each pair of bell-jars, and matters so adjusted that the ordinary air passed into the No. 1 jar unaltered; but

before entering Nos. 2, 3, and 4 the stream of air was deprived of any ammonia or nitric acid it contained. The plants all grew normally, and passed successfully through the usual starvation stage. When the experiment was stopped they had grown to a height of 120cm., and had entered on the flowering and fruiting stage. Subsequent analysis showed that the plant grown in the ordinary air did not yield as much dry substance in the straw and roots together as did the plants grown in the purified air. Several repetitions of this experiment made it quite clear that the small traces of combined nitrogen present in the air did not supply the experimental plants with the nitrogen which they somehow obtained. The only hypothesis that could now be entertained was that somewhere and somehow the leguminous plants do make the free nitrogen of the air available for their nutrition.

In the course of Hellriegel's experiments he noticed that, while some plants grew in a soil devoid of nitrogen and under the conditions already described, others grew badly, and some never recovered from the starvation stage. Repeated and careful examination of the experimental plants brought to light a remarkable fact. The plants that remained in the starvation phase had either no tubercles on their roots or very few and insignificant ones, whereas the plants that throve and grew luxuriantly had many well-developed tubercles on their roots. The more plants Hellriegel investigated the more was he convinced that the development of the root-tubercles stood in the closest and most direct relation to the growth and assimilation of the whole plant. The origin of the root-tubercles had now to be investigated. It was likely that they were caused by the invasion of the root-tissues at certain spots by micro-organisms existing in the soil. To test this supposition Hellriegel carried out numerous experiments. A brief account of two of these will show his methods and his results.

On a certain day (25th May) were taken forty vessels filled with soil devoid of nitrogen, and two pea-seeds were planted in each. Ten of the vessels were then watered with washings from the fertile soil of the culture field in which micro-organisms existed in abundance. Thereafter these vessels, and from the first all the others, were watered with pure distilled water. In about three weeks the aspect of the plants was changing, and all turned pale as the seed reserves were exhausted. So far there was no difference to be seen between the forty cultures. But a difference soon set in, and in another week it was most decided. In the ten vessels supplied with bacteroids all the plants had regained their fresh-green colour, and commenced to grow vigorously. Of

the other thirty vessels in which the introduction of micro-organisms was left to chance, only two at this stage presented a similar appearance, all the rest were still starving and in part yellow. A fortnight later the plants in the ten vessels were developing their tenth leaf and growing luxuriantly. Of the sixty plants in the other culture-vessels which had not been supplied with bacteroids ten were now nearly as flourishing as the above, while five were nearly dead. Among the remaining forty-five plants all stages between these extremes were to be found. An examination of the roots of the best grown and the worst grown plants fully confirmed the relation between the growth of the sub-aerial parts and the development of root-tubercles. This experiment did not, however, furnish a decisive answer to the question of the source of infection of the roots with the organisms that produce the tubercles. Abundant tubercles had appeared on plants grown in culture-vessels to which no soil-washings had been deliberately added, the micro-organisms having been introduced in some unknown and accidental way.

The question was attacked anew, and this time with more decisive results. Two cultivations were made in soil free from nitrogen, to which the usual non-nitrogenous nutritive mixture, and, in addition, a small amount of the above-mentioned soil-washings, were added. The culture vessels thus charged were then sterilised by heating, after which the seeds were sown and the surface of the soil covered over with sterilised wadding. All went well until the development of the sixth leaf and the setting in of the usual starvation stage. After this the plants made no further progress, and before long all of them died. No tubercles were formed on the roots under these circumstances, and numerous repetitions of the experiment always gave the same results. These experiments show conclusively that the formation of the root-tubercles is dependent on the presence of living micro-organisms in the soil, which infect the roots, and that in the absence of root-tubercles leguminous plants are exactly in the same case as other plants —they pass into a condition of permanent starvation as soon as the food reserves of the seed are exhausted, just as gramineous plants do when grown in a medium devoid of available nitrogenous compounds.

Hellriegel sums up the outcome of his researches in these terms: "Leguminous plants, in contrast to the gramineous ones, are not dependent on the soil for their nitrogenous nutrition." As to the source of their supplies of nitrogen, he adds, "Not one of my experiments supports the idea that it is to be found in the minute quantities of combined nitrogen

that exist in the atmosphere. Thus, probably, the only remaining assumption we can make is that leguminous plants have the power of making use of the free nitrogen of the air. To their nutrition, and especially to their assimilation of nitrogen, the so-called tubercles and the organisms that dwell in them stand in the closest active connection."

Many other observers have taken part in the elucidation of this subject, and Hellriegel's results have been abundantly verified both in England and on the Continent. The most rigorous confirmation has been supplied only two or three years ago by Laurent and Schlœsing. These inquirers grew leguminous plants from seed in a sterilised glass apparatus of great beauty and ingenuity, which provided for the supply of pure water and carbon-dioxide to the foliage exposed to the light, as well as for the circulation of air known to consist of oxygen and nitrogen in the free state only, all nitrogenous compounds being taken out. Samples of the air could at any time be taken out and analysed, and at the close of the experiment the whole of the air affected by the growing plants could be collected and examined. In this way Laurent and Schlœsing proved not only that the nitrogen increased in the growing plants, but that a corresponding amount of nitrogen had been removed from the air that surrounded them. This result was got only when the experimental plants were infected with bacteroids and well provided with root-nodules. If the bacteroid organisms were not added no tubercles appeared, and the plants starved.

This research proves in the most conclusive way that the nitrogen fixed by infected leguminous plants is taken from the air, and must be taken as free nitrogen.

So far as leguminous plants are concerned, the modern results are of course in direct conflict with those which Boussingault was thought to have established about the middle of the century. The discrepancy is due to the fact that bacteroid infection was excluded in Boussingault's experiments, one main object of which was to show that humus and its immediate derivatives were not necessary, and, indeed, not directly available, for the nitrogenous nutrition of plants.

The fact of the fixation of the free nitrogen of the air by infected leguminous plants being thus finally and firmly established, the exact mode or process of the fixation remained to be explained.

At first various opinions on this subject were held by competent inquirers. Hellriegel's and Laurent and Schlœsing's investigations have made some of these untenable. One view, which is still maintained by Frank of Berlin, was that the Leguminosæ took up the free nitrogen of the air by their leaves. The experiments of Hellriegel, already described, and others

conducted with even greater rigour by Laurent and Schlœsing, show that this view is untenable. Frank is its only prominent advocate at the present day, and the experiments on which he relies are generally held to be inconclusive. Another view was that the Leguminosæ, with their abundant and deeply penetrating root-system, could take up nitrogenous compounds from the lower layers of the soil which other plants could not reach. On this view we cannot understand why the presence of numerous well-developed tubercles in the roots should be a necessary condition of the abundant assimilation of nitrogen. It is, moreover, directly refuted by the abundant fixation of nitrogen by plants grown in shallow culture-vessels and in soil devoid of nitrogenous compounds of any kind.

Two other views have been entertained, and both are more or less consistent with the results of experimental inquiry. But before dealing with these let me describe somewhat more fully the nature of the nodules and their contained organisms, and of the relations of the latter to the living plant which they affect

In 1887 Professor Marshall Ward showed that a perfectly definite organism from the soil penetrates the root-hairs, and invades the cortical tissues of the roots. The organism lives in a sort of helpful association (or in symbiosis as the specialists have it) within the tissues of the root-tubercles, and not merely as a hurtful parasite. Instead of injuring the leguminous plant, the nodules and their living invaders in the long run add to its health and vigour. What follows the infection is briefly as follows: The invading organism causes the cells deep down in the cortical tissues (the tissues that correspond to the bark in stems) to divide and form a delicate tissue of well-nourished cells. As these enlarged cells multiply the organisms keep pace with them, and send branches into each new cell. Eventually myriads of minute bacterium-like bodies fill the cells. The cells are not, however, killed by the bacteroids; on the contrary, they show all the signs of intense physiological activity, accompanied by the destruction of copious supplies of carbo-hydrates brought to them from the leguminous plant. After a time this metabolic activity abates, and the myriads of bacteroids begin to get disorganized. Then the now victorious leguminous plant absorbs the disintegrated contents of the interior of the nodules, taking up everything that is capable of solution and absorption, and leaving the nodule a nearly empty, limp, collapsed shell, in which such bacteroids as have passed into a sort of resting-stage alone remain alive, to be scattered in the soil as the *débris* of the exhausted nodule rots away.

It looks as if the invading organism acted at first as a parasite, but though it lives at the expense of the cells which

it has enslaved and forced to intense metabolic activity it does not destroy them. The next stage is one in which the struggle for mastery between the pseudo-parasite and its host is most intense. For a time the bacteroids take everything the cell can give them; they multiply and fill the cells, and then gradually pass into a passive condition. The leguminous plant now gains the mastery, and the cells of the nodules absorb and pass on into the plant almost the entire store of nourishing substances which the bacteroids have accumulated.

Now, there can be no reasonable doubt that the fixation of the free nitrogen occurs in the underground part of the plant. The known anatomical structure of the nodules, especially the complex and very regular system of vascular bundles that connect them with the mother-roots, and the abundant supply of carbo-hydrates passed into the nodules, make it extremely probable that the seat of the action lies in the nodules themselves. We may therefore suppose either that the inert nitrogen molecules are forced into the organic synthesis in the cells of the bacteroids, or that the metabolic activity of the cells composing the nodules, and it may be adjacent parts of the roots also, is so exalted by the stimulating action of the bacteroids as to be able to build up compound proteids by the synthesis of gaseous nitrogen with the already elaborated carbo-hydrates. It is difficult to arrange experiments that will settle decisively which of these views is the correct one. Attempts to demonstrate that the bacteroid cultivated outside the plant can assimilate free nitrogen have hitherto failed. But we must not lay too much stress on such negative results, because the cultivation of an organism so highly adapted to its symbiotic life as this evidently is may well fail outside the cells of the host. On the other hand, it is improbable that the cells of the bacteroids would assimilate, and by their disintegration and absorption pass on to the infected plant, such quantities of nitrogen as are known to be fixed from the air by the Leguminosæ. On the whole, we may conclude that the view adopted by Hellriegel and many other inquirers, that the cells of the nodules are the actual seat of the fixation of the free nitrogen of the air, is the true one.

How the fixation is brought about we cannot in the present state of knowledge explain, though theoretical considerations carry us some way towards an explanation of the phenomenon. In the ordinary course of plant metabolism nitrogenous bodies —*e.g.*, amides—preceded, it may be, by simpler compounds, are built up by the living cell protoplasm from carbo-hydrates and nitrates, the energy required to effect this synthesis being chiefly if not wholly derived from the indirect oxidation of

part of the carbo-hydrates supplied to the cells. It is this indirect oxidation that produces the carbon-dioxide that is continuously given off by living plants. This constructive metabolic work of the protoplasm is an act that we cannot explain in detail; when we can, we shall indeed have solved the mystery of life. We can only dimly perceive that the synthesis depends on some peculiar power possessed by the protoplasm of presenting the atoms and molecules to each other. We may therefore suppose that the cell machinery of the roots or the nodules is so exalted in activity by the presence or the products of the bacteroids as to be able to force the notoriously inert nitrogen into combination with other molecules, so as to produce nitrates, or amides, or other similar bodies. The energy required for this transformation is no doubt supplied by the oxidation of part of the abundant stream of starch and other carbo-hydrates, as well as salts, that is conveyed to the nodules from the roots, the surplus of these substances being alone available for entering into combination with the nitrogen directly assimilated from the air. It has been suggested that, as the sap expressed from the active tissues of the nodules is alkaline, the cell protoplasm in the presence of, an alkali and free nitrogen may be able to build up ammonium-nitrite or some such body. On this view, all that seems required for the forcing of nitrogen into the organic synthesis is a sufficient supply of carbo-hydrates. But this does not explain the whole difficulty, else why cannot the well-nourished cells of any plant do the trick?

Though we are unable, and are likely to remain unable, to explain in detail the process of nitrogen fixation, the results of the researches I have detailed do not on that account lose anything of their importance. They constitute a clear and a most valuable addition to our assured knowledge of the nutrition of a large class of agricultural plants. To the farmer, the forester, and the gardener, the new knowledge is of the very highest significance. The farmer now knows that he has at his disposal a simple, certain, and most economical means of enriching his land in nitrogenous compounds by the spontaneous bounty of nature. To avail himself of this he needs only to grow a judicious mixture of leguminous and gramineous plants in the same crop, or to use a suitable rotation of leguminous and other crops in successive years. Clover, lucerne, peas, beans, and sainfoin are good examples of useful leguminous crops, and they all possess a very extensive and well developed system of roots. When the crops are harvested or eaten off by stock, the abundant root-system decays in the soil, and leaves it much richer in nitrogenous compounds than it was before. The soil is thus, by the mere act of nature, endowed with large supplies of a prime necessary of

plant life; one, too, which it costs the farmer much more to supply in the form of manure than any other important ingredient that cultivated soils are apt to be deficient in.

The lesson which the farmer should learn from the new knowledge is obvious enough. Every few years he must break up his land and grow a crop of one or other of the common useful leguminous plants, such as peas, beans, lucerne, or clover. His land will thus be sufficiently supplied with nitrogenous compounds, and he will have to add to it only such other less expensive and scarce elements of plant food as the soil may require. Clovers, too, will be grown along with grass-crops, but this method is not so likely to yield satisfactory results, as clover-plants die out in a few years, and are apt to induce the condition known as clover sickness. This undesirable condition of the soil can be partly avoided by providing it with sufficient stores of potash and lime, and more effectually, and also more economically, by following a sub-rotation of clover-plants in the general rotation of crops—red-clover, white-clover, and alsike being sown in alternation, when the leguminous crop of the general rotation becomes due. It is, however, clear that lands laid down in permanent pasture cannot be greatly enriched by gains of nitrogenous compounds accumulated by the roots of leguminous plants, since hardly any useful plants of this kind can be grown in the same soil for a long series of seasons. It is therefore only in lands that are cultivated with some regularity that the farmer can draw to the best advantage on the bounty of nature for the enrichment of his land.

I need not dwell upon the application of the new knowledge to the economic management of forests, orchards, and gardens. It must suffice to point out that it has obvious and important bearings on each of these pursuits.

There are many other points connected with the relation of the nitrogen of the air to the soil to which it would be interesting to refer, but the time at my disposal will not allow me to touch on more than one of them.

Observers, even thirty years ago, had no doubt that the soil in which plants grow was a comparatively simple medium, consisting of a mixture of sand, clay, lime, humus, and traces of other mineral substances. The modern botanist has learned that the soil is a vastly more complex substance than that. He has learned to recognise that every fertile soil abounds in microscopic organisms, often to a degree that is truly startling. The earlier estimates may be passed over as less trustworthy than more recent ones. The latter, however, are sufficiently startling, for they show that in a cubic centimetre of rich sandy soil from ten to forty millions of germs may be found. In fact, we may look for from one to ten

millions of germs in a thimbleful of such soil. These numbers are, it must be admitted, sufficiently bewildering. And what are these microscopic organisms doing? A few of them are undoubtedly injurious parasites; others are the fungi and bacteria that live as saprophytes on decaying vegetable and animal remains, and are the active agents in the fermentations and putrefactions which resolve organic substances into the forms of carbon-dioxide, water, and ammonia. Others have the power of oxidizing ammonia first to nitrous and then to nitric acid, and are doubtless the chief agents in nitrification, while still others undo the work of the last by degrading the highly oxidized salts of nitrogen, deoxidizing nitrates to nitrites, and the latter to ammonia and even free nitrogen.

Besides these, evidence is accumulating that points to the existence of forms which, provided there are plenty of carbohydrates available, can actually fix free gaseous nitrogen in their living machinery, and compel it to enter into the organic synthesis. Winogradsky, who has isolated and studied organisms of this kind at the Pasteur Institute Laboratory, suggests that in its life processes nascent hydrogen is set free, which combines with the free nitrogen of the air to build up ammonia.

These results are still so recent that I have not heard of their verification by other observers, but should they be confirmed they show us that the very process of nitrogen fixation, which occurs normally in the root-nodules of leguminous plants, takes place in microscopic organisms that lie detached in the soil, and indicate possibilities of nitrogen storage in the soil that have hitherto not even been suspected. Winogradsky's observations, too, lend additional probability to the hitherto doubtful view that it is the bacteroid cells that constitute the actual seat of nitrogen fixation in the root-nodules of the Leguminosæ. However this may be, it is obvious that the whole question of the supply of nitrogen to vegetation is taking new turns. We feel that we are steering on the brink of new and fruitful discoveries that may revolutionise the whole practice of agriculture, and even restore the prosperity of the agricultural interest in spite of the world-wide decline in the values of nearly all cereal and other products which the soil yields. Let us, in conclusion, note that the advances in knowledge which I have endeavoured to explain have been won by eminent investigators, hailing from every one of the great civilised nations of Europe. Original memoirs relating to the investigations I have been discussing have appeared in nearly every European language, and only a polyglot could fully follow the more important researches in this one subject. In these days when the jealous nations are snarling at each other's heels, it is no small consolation to

realise and reflect on the splendid and generous spirit of international co-operation and friendly rivalry that now happily prevails in the investigation of every branch of accurate and useful knowledge.

Art. XXXIX.—*On New Zealand Mosses.*

By T. W. Naylor Beckett, F.L.S.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1896.*]

Plates XXIV.-XXVI.

Tortula petriei, sp. nov., "a congeneribus foliis late flavo-limbatis facillime dignoscenda," Broth. Plate XXV.

Synoicous, in dense patches, stems short, 0·3in. long, simple or dichotomously branched. Leaves at base of stem small oblong ovate, above ovate-lanceolate tapering gradually to apex, upper part near apex finely but irregularly serrate, olive-green; border continuous from base to apex consisting of long blunt-ended cells, 0·0037 to 0·004 wide, orange-yellow; nerve rufous, stout, excurrent in a short stiff mucro; cells at the base rectangular, yellowish, gradually merging into small roundish hexagonal opaque chlorophyllose cells. Seta nearly 1in. long, red, smooth; capsule 0·2in. long, cylindric, slightly curved, smooth, reddish-brown. Peristome, tube dull-red, obscurely tessellated, 0·06in. long, teeth one-third length of tube. Operculum and calyptra not seen. Male inflorescence mixed with female; paraphyses numerous, clavate.

Hab. Kelly's Hill, Westland; collected by Mr. D. Petrie.

A very handsome species, well marked by the very striking yellow border to the leaves.

Zygodon mucronatus, sp. nov., "a *Z. menziesi* proximo foliis nervo excedente mucronatis differt," Broth. Plate XXVI.

Synoicous, in small cushioned tufts. Stems 0·3in. long, fastigiately branched, fuscous and radiculose at base. Leaves when moist patent, ovato-lanceolate, stout, margins flat entire; nerve brown, very strong, excurrent, in a stiff mucro; cells at base rectangular, above roundish or oval hexagonal. Perichætial leaves like the leaves, but smaller and less dense. Seta 0·1in. long or more. Capsule when dry furrowed, broadly oval; mouth small. Peristome single, of 8 bigeminate blunt obtuse teeth; operculum short, conic, apex slightly inclined. Calyptra not seen.

Hab. On bark of *Myoporum lætum*, near the sea, Kaikoura; December, 1889. *T. W. N. B.*, No. 504. Determined by Dr. V. F. Brotherus.

Grimmia mutica, Hampe.

"Laxe pulvinata, rufo-fusco-nigricans, fere uncialis; caulis adscendens, basi nudiusculus, superne dense-foliosis, sterilis cuspidatus, fertilis clavatus; folia sicca appressa, humida recurvato-patentia, carinata, margine reflexo, nervo ad apicem producto, ovato-lanceolata, obtusiuscula, mutica; cellulis subrotundis minimis densioribus, fusco-lutescentia, vel opaca, perichætialia latiora erecta; theca deoperculata ovato-elliptica immersa brunnea; dentibus peristomii lanceolatis subintegris ferrugineis."—"Linnæa," 1859–60, p. 631.

Hab. On exposed rocks, Ben More, Canterbury; *T. W. N. B*, No. 509: on boulders in river, Waimate, South Canterbury; *T. W. N. B.*, No. 497. Determined by Dr. V. F. Brotherus.

Macromitrium (Goniostoma) weymouthii, Broth.

"Gracile, prostratum, intertexum, læte viride, demum ferrugineum; caulis longe repens, vage ramosus, ramis densissime ramulosis, ramulis brevibus, strictis vel curvatulis, dense foliosis; folia sicca adpressa, apice incurva spiraliter contorta, humida erecto-patentia oblongo-lanceolata, acuta, marginibus inferne plus minusve revolutis, integerrimis, nervo lutescente, infra apicem evanido, cellulis basilaribus elongatis, valde incrassatis, lumine angustissimo, supra medium folii rotundatis, valde incrassatis, lumine minutissimo, omnibus pellucidis, lævissimis; bracteæ perichætii erectæ, majores acuminatæ; seta erecta, curvato-flexuosa, 8–15mm. alta, lutea, lævissima; theca erecta, ovalis, evacuata ore plicata, microstoma, badia; peristomium simplex; exostomii dentes infra orificium orundi, breves, grisei, papillosi; operculum rostratum, rostro dimidiam partem thecæ vix superans; calyptia sordide lutea, apice ferruginea, glabra. *Patria:* Tasmania.

"A *M. scottiæ*, C. Müll., proximo foliis acutis nervo infra apicem evanido nec non cellulis minoribus prima scrutatione differt. An *M. scottiæ*, Mitt., Austr. Moss. e Tasmaniâ?"—V. F. Brotherus, "New Species of Australian Mosses," in Ofversigt af Finska Vet. Soc. Föhr, Helsingfors, 1895.

Hab. On trees, junction of Bealey and Waimakariri Rivers; altitude, 2,040ft.; *T. W. N. B.*, No. 329: determined by Dr. Brotherus. On trees, Little Kowai River, Mount Torlesse; *T. W. N. B.*, No. 394.

Macromitrium eucalyptorum, C. Müll. and Hampe.

"Monoicum *Macromitrium tenui* simillima sed folia caulina angustius lanceolata acutiora glabriora ad basin minus con-

cavium paulisper revoluta, perigonialia margine basilare denticulata; theca brevius pedunculata oblonga minor (nec cylindrica). In truncis Eucalyptorum putrescentibus, Bunyip Creek, Nova Hollandia."—"Linnæa," 1853, p. 500.

Hab. On trees, Kowai Bush; *T. W. N. B.*, No. 252B: determined by Dr. Karl Müller. Common on trees (and rarely on rocks?) throughout the islands.

Syn. M. microphyllum, Hook. and Grev., in Fl. N.Z., but not *M. microphyllum*, Bridel; *M. barbatum*, Mitt., MSS. Specimens from Dunedin, in Mr. W. Bell's herb., are thus named by Mr. Mitten.

Leucobryum brachyphyllum, Hampe.

"Laxiusculo cæspitosum; caulis breviusculus ramosus; folia brevia stricta oblongo-lanceolata vix falcata apice (cellulis dorso valde prominulis) valde serrata basi vix marginata; perichætialia sub-breviora caulinis similia stricta vel subundulata maxime serrata, intima lævissima longiora cuspidata e basi usque fere ad apicem lato-marginata longiora subexserta integerrima; theca lateralis longepedunculata obconica cernua exacte strumosa ore dilatata operculo longirostrato obliquo purpureo instructa brevis olivacea."—"Linnæa," xiii.; C. Müll., Syn. i., p. 76.

Hab. Herekino, extreme north of Auckland peninsula; collected by *D. Petrie*; No. 595: determined by Dr. Brotherus. Found in New South Wales and Queensland.

Bartramia pomiformis (L.), Hedwig.

Hab. Maungatui, near Dunedin; Kinloch and Mount Alfred: *W. Bell.* Determined by Dr. Brotherus.

This common European and North American moss was found in Fuega, Straits of Magellan, and its occurrence in New Zealand is most interesting.

Mielichhoferia eckloni, Hornsch. Hook., Fl. Tasm., ii., 189.

Hab. Kelso, Otago; November, 1891: *D. Petrie*: determined by V. F. Brotherus. Pine Hill; November, 1890: Roxburgh; February, 1891: and Kinloch; January, 1891: in Herb. Bell: determined by V. F. Brotherus.

Mniobryum tasmanicum, Broth. Plate XXIV.

"Dioicum; cæspitosum, cæspitibus elatis, laxiusculis, mollibus, pallide glauco-viridibus, haud nitidis; caulis ad 8cm. usque altus, erectus, flexuosus, ruber, inferne fusco radiculosus, innovando ramosus, innovationibus gracilibus usque ad 3cm. longis, laxe foliosis; folia patentia, innovationum patula, omnia subæqualia, subplana, breviter decurrentia, lineari-lanceolata, acuminata, acuta, c. 3mm. longa et 0·47mm.–0·53mm. lata,

marginibus ubique erectis e medio ad apicem argute serrulatis, haud limbata, nervo tenui, basi c. 0·05mm. lato, infra apicem evanido, cellulis elongatis, angustis in medio folii 0·175mm.–0·225mm. longis et 0·015mm. latis, omnibus subæqualibus, leptodermibus, lævissimis. Cætera ignota. *Patria:* Tasmania, Mount Wellington: *W. A. Weymouth.*

"A *M. albicanti* (Wahl.), proximo foliis angustioribus, anguste acuminatis, e medio ad apicem argute serrulatis nec non cellulis multo longioribus et angustioribus, prosenchymaticis optime differt."—V. F. Brotherus, "New Species of Australian Mosses," part ii.

Hab. Pine Hill, Dunedin; in Mr. W. Bell's herb.; determined by V. F. Brotherus.

I am indebted to Mr. Weymouth, the original discoverer of this moss, for authentic specimens, from which my figure has been drawn.

"**Lembophyllum**, Lindb., n. gen. antarcticum, *Hypnum vagum*, Hornsch.; *H. divulsum*, H. f. and W.; *H. clandestinum*, H. f. and W.; *H. cochlearifolium*, Schwægr et aff. includens, statim differt ramis e rhizomate erectis, arcuato-decurvatis, irregulariter pinnatis, foliis patentibus, quam maxime cymbiformi-concavis, angulis fere semper excavatis, raro apiculatis, nervis binis vel subnullis, cellulis angularibus distinctis, ceteris vulgo oblique seriatis, valde incrassatis, ovalibus prosenchymaticis, bracteis perichætii luteis, binervibus vel subenervibus, cellulis angustis et valde incrassatis."—S. O. Lindberg, Contrib. ad floram cryptogamam Asiæ boreali-orientalis (Helsingfors, Acta Soc. Sci., fennicæ x. (1872), p. 277).

The following New Zealand species must be placed in this new genus:—

Lembophyllum cochlearifolium (Schw.), Lindb. *Hypnum cochlearifolium*, Hook. and Wils., Fl. N.Z., ii., p. 111.

L. clandestinum (H. f. and W.), Lindb. *Hypnum clandestinum*, H. f. and W., Fl. N.Z., ii., p. 111.

L. chlamydophyllum (H. f. and W.), Lindb. *Hypnum chlamydophyllum*, H. f. and W., Fl. N.Z., ii., 111.

L. vagum (Hornsch.), Lindb.

L. divulsum (H. f. and W.), Lindb.

L. micro-vagum, Beck., in Trans. N.Z. Inst., 1893, xxvi., p. 275.

Amblystegium sarmentosum (Wahlenb.), De Not.

Hab. Kelly's Hill, Westland: *D. Petrie*, No. 135. Determined by V. F. Brotherus.

Dr. Brotherus remarks that this is a very interesting

species, which in no way differs from Lapland specimens. It is new to the Australasian flora

Hypnum cuspidatum, L.

Hab. Pelichet Bay, Otago; May, 1888: in Herb. Bell. Determined by Dr. Brotherus. Another northern moss now first recorded in New Zealand.

Fissidens vittatus, H. f. and W., in Fl. Tasm., ii., 167.

Hab. Strath Taieri, Otago; March, 1888: in Herb. Bell. Determined by Dr. Brotherus. A Tasmanian moss not hitherto recorded in New Zealand.

EXPLANATION OF PLATES XXIV.-XXVI.

PLATE XXIV.

Mniobryum tasmanicum.

Fig. 1. Leaf, × 32.
Fig. 2. Apex of leaf, × 70.
Fig. 3. Cells and edge of leaf, × 270.
Fig. 4. Leaf of innovation, × 32.

PLATE XXV.

Tortula petriei.

Fig. 5. Plant, nat. size.
Fig. 6. Leaf, × 32.
Fig. 7. Lower leaf, × 32
Fig. 8. Apex of leaf, × 70.
Fig. 9. Cells from base of leaf, × 70.
Fig. 10. Cells, centre of leaf, × 270.
Fig. 11. Cells of border and edge of leaf, × 270.
Fig. 12. Peristome, × 32.

PLATE XXVI.

Zygodon mucronatus.

Fig. 13. Plant, nat. size.
Fig. 14. Leaf, × 32.
Fig. 15. Apex of leaf, × 270.
Fig. 16. Cells at edge of leaf, × 270.
Fig. 17. Cells at base, × 270.
Fig. 18. Perichætial leaf, × 32.
Figs. 19 and 20. Capsules, × 32.
Fig. 21. Tooth of peristome, × 270.

Art. XL.—*Notes on Several Species of* Delesseria, *One being New.*

By Robert M. Laing, B.Sc.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1896.*]

Plates XXVII and XXVIII.

Delesseria crassinervia, Mont., Voy. au Pôle Sud.

Hooker, in his "Handbook of the New Zealand Flora," p. 683, amongst other species of *Delesseria*, includes *D. crassinervia*, originally described by Montagne (Prodr. Ant., p. 3), but afterwards more fully described and figured by the same writer in Voy. au Pôle Sud: Botanique, vol. i., p. 164, and tab. 8, fig. 1. In the Handbook the New Zealand habitats of the plant are given as the Auckland and Campbell Islands, and also, on the authority of Lyall, Ruapuke Harbour and Stewart Island. Montagne's plant came from the Auckland Islands.

J. G. Agardh, on the other hand ("Epicrisis Floridearum," pp. 490 and 492), discards the specific name *crassinervia* from his list of recognised species, retaining it only in a foot-note with Montagne's original description attached. He, however, describes, on his own authority, a species, *D. montagneana*, which he doubtfully considers—and erroneously as I believe—to be *D. crassinervia*, Mont.; and he also states—again erroneously—that Hooker's plant is not entitled to its specific name, as it is different from Montagne's. He himself does not adopt the specific name *crassinervia*, as he considers his plant differs in some important details from the description given by Montagne (Prodr. Ant., p. 3). He considers it safer to redescribe his species under the new specific name—*i.e.*, *D. montagneana*. The *D. crassinervia* of Harvey (*i.e.*, of Hooker's Handbook) he refers to a new species, *D. phyllophora*, remarking that apparently several species have been confounded under the name *D. crassinervia*.

Now, I wish to show—(*a*) That we have in New Zealand *D. crassinervia*, Mont., and that the specific name must therefore stand; (*b*) that *D. crassinervia* of the Handbook probably includes two species, one of which is the true *D. crassinervia*; (*c*) that apparently Agardh has not seen *D. crassinervia*, Mont., and consequently has endeavoured to assimilate it to several other species, and that therefore he is quite in error in his attempt to explain away the specific value of the name.

(*a*.) Montagne's specimen was apparently an old one, or

else a winter form; but I have had in my collection for several years a specimen from the Mongonui Beach, at the Chatham Islands, which agrees in all points of specific value with the figure of Montagne, and with the descriptions both of Montagne and Harvey. I append a description of the plant. During the Christmas holidays of last year I collected the same species amongst the drift-weed at St. Clair, and afterwards, in company with Mr. J. Crosby Smith, I obtained it growing epiphytically on *Carpophyllum*, at Wycliffe Bay, Otago Peninsula.

(*b*.) The description given in the "Handbook of the New Zealand Flora," although very imperfect, agrees almost perfectly with the specimens I have collected; but the following instructive note occurs in Agardh's "De Algis Marinis Novæ Zelandiæ," p. 25, under the name *D. montagneana*: "Specimina *D. crassinerviæ*, Harv., nulla e N. Zelandia vidi, ex insulis Falkland, manu ni fallor Harveyi nomine *D. crassinerviæ* inscripta, me judice ad speciem admodum diversam pertinent, quam *D. phyllophoræ* nomine descripsi."

Now, as it is quite clear from the description of *D. crassinervia* and *D. phyllophora* (J. Ag., Bidr. Fl. Syst., p. 55) that they are distinct plants, and if Agardh is right in supposing that his specimen of *D. crassinervia* from the Falklands is inscribed in Harvey's handwriting, it is quite clear also that the latter has confused two distinct plants under this name. Be this as it may, it does not in any way interfere with the validity of the species *D. crassinervia*, and is only introduced here in order to avoid, if possible, subsequent confusion and misconception as to the limits of the species.

(*c*.) Agardh, while not definitely rejecting the species *D. crassinervia*, doubtfully splits it up into three—viz., *D. phyllophora*, J. Ag., *D. montagneana*, J. Ag., and *D. epiglossum*, J. Ag.—and hesitatingly admits the possibility of a fourth, the true *D. crassinervia*, Mont. I expect Agardh's three species are genuine, but they are certainly distinct from my plant, and not *D. crassinervia*. As I have already explained, *D. montagneana* is intended to replace doubtfully *D. crassinervia*, Mont.; *D. phyllophora* is *D. crassinervia*, Harv. (from Falkland Islands), but it is not at all clear to me why he should consider *D. epiglossum* as possibly in part equivalent to Harvey's plants, unless he doubted the accuracy of the description given in the Handbook. It now only remains to show how the three species mentioned above can be readily distinguished from my plant, which is, I believe, the true *D. crassinervia*, Mont.; and this is easily done. Indeed, the following note from Agardh, taken in conjunction with the one already quoted, not only does this for us, but clearly explains how all the confusion has arisen:—

("Epicrisis Floridearum," p. 493.)

D. montagneana: "Sunt in magnitudine et ramificationis norma hujus multa, quibus cum *D. crassinervia*, Mont., convenire videtur. Obstat vero quod de microscopicis venis, admodum conspicuis in nostra, nullum verbum, habet Montagne. Suam plantam evidenter senilem, et lamina in pluribus ramis derasa forsan hyemalem, cujus in frondibus juvenilibus paucis venæ parum conspicuæ adessent, credere propensus fuissem, nonnullas tamen, frondes lamina instructas vidit et depinxit; venasque in his, si adfuissent, ab eò prætermissas fuisse eo minus assumere fas est, quam jam tunc temporis præsentiam aut defectum venarum characteres cujusdam momenti in speciebus proximis dignoscendis præbere cognitum fuit."

The absence of transverse venation in Montagne's plant is evidently, then, the stumbling-block that prevented Agardh from discarding altogether the specific name *crassinervia*; but there are no transverse veins microscopic or macroscopic in my specimens, and this at once separates it from *D. epiglossum*, *D. phyllophora*, and *D. montagneana*, and gives an additional reason for regarding it as the true *D. crassinervia*. It also differs from them in many other points of habit, size, &c.; but upon these I need not dwell. From the following description it will be seen that the plant must be placed under Agardh's sub-genus *Hypoglossum*:—

D. crassinervia, Mont.

Root a small disc. Main stem flat, corticated, costate to the tips, narrowing somewhat towards the disc, originally bordered with a wing 3mm.–4mm. wide, which disappears in the older plants, leaving only the broad costa 2mm.–4mm. wide. Costa of pinnæ and pinnules similar to that of the main stem, and also narrowing somewhat towards the point of insertion. Frond a bright lake-red extremely thin and flaccid, decomposing rapidly but retaining its colour well if dried when quite fresh, 25cm.–40cm. long, general outline linear, oblong-ovate, or broadly elliptical or irregular, as the pinnæ and pinnules do not develope in acropetal succession; irregularly bipinnately or tripinnately compound. Pinnæ and pinnules proliferous winged, but giving the appearance of a distichous frond owing to the abrasion of the lamina, costated to the tips, but not otherwise veined. Pinnæ 10cm.–15cm. long, pinnules 2cm.–4cm. long, linear-acuminate, bearing proliferous sporophylls, which are developed singly on each side of the costa and on both sides of the lamina. Sporophylls 3mm.–4mm. long, linear or ovate, slightly stipitate, costate to the tip,* but not otherwise veined, microscopically and irregu-

* The costa is externally evanescent, but the costal cells can be traced to the tip with the microscope. *Vide D. linearis.*

larly serrulate, bearing in two oblong patches on either side of the costa numerous irregularly-arranged tetraspores of the usual type. The tetraspores are not confined to the sporophylls, but are also found below the apices of the pinnules, where the sporophylls are absent. Cystocarps not seen.

Hab. St. Clair, Dunedin; Wycliffe Bay, Otago Peninsula; Mongonui, Chatham Islands! (Ruapuke Harbour and Stewart Island: *Lyall* Lord Auckland Group and Campbell Islands: *Sir J. D. Hooker*)

Delesseria linearis, sp. nov.

I have had for some time in my possession what is apparently a very distinct species of *Delesseria*, not yet described. I have found it at Lyall's Bay on two occasions only, once growing on a Coralline, and on the second occasion epiphytic on *Pterocladia*. It is apparently rare. On account of its shape I propose to call it *D. linearis*. The species is remarkable for the complete disappearance of the costa about one-third of the way up the frond. Agardh, in his description of the genus ("Epicrisis Floridearum," p. 478), states that, "in those species in which the costa is more or less obsolete and evanescent externally, the costal cells are nevertheless rather frequently continued to the tip In these species the whole longitudinal increase in length of the frond is seen to depend upon the evolution and subdivision of these cells." This is the case with *D. crassinervia*, in which the costa becomes externally obsolete a few millimetres from the apex of the frond; but the longitudinal row of cells of which it is formed may be traced to the growing point, where they terminate in a single cell. In *D. linearis*, however, the costa disappears completely about one-third of the way from the base of the frond, and there is beyond that point no differentiation of the parenchymatous cells. However, a terminal cell is readily seen, and below it the cells are flabellately arranged, evidently as a result of its division. In other respects the plant conforms to the normal type of the genus.

Hab. Lyall's Bay, Cook Strait.

Description of species: *D. linearis*, sp. nov. Frond simple, linear sessile, narrowed towards the base, epiphytic, 40mm.–50mm. long, 4mm.–5mm. broad, apex obtuse, margin entire. Costa indistinct, disappearing one-third of the length of the frond from the base, otherwise without veins. Sporophylls arranged in acropetal succession up the centre of the frond, generally singly (but two or three sometimes spring from one point, and sometimes secondary sporophylls of similar character arise from the backs of the primary ones), suborbicular, emarginate, and slightly stipitate, 1mm.–2mm. in diameter. Numerous tripartite tetraspores occupy the whole surface of

the sporophyll, excepting the narrow outer margin. Cystocarps not seen.

D. lancifolia, var. *minor*, n. var.

Owing to the kindness of Mr. A. Hamilton, of Otago University, I have received a few fragments of seaweed, collected by him at the Macquarie Islands. Amongst these is a *Delesseria*, which I find myself unable to distinguish specifically from *D. lancifolia* (J. Ag., Bidr. Fl. Syst., p. 59). Harvey regarded this latter plant as merely a variety of *D. sanguinea*; but Agardh, who has, however, only one fertile specimen of the plant, considers it a distinct species. My plant differs from Harvey's in being very much smaller, and unbranched, and apparently, also, in bearing sori only on the sporophylls. None of these points, however, may be constant, and so I do not think it necessary at present to describe it as a fresh species, but have assigned to it the varietal name *minor*.

Hab. Macquarie Islands.

Description of variety: *D. lancifolia*, var. *minor*. Frond simple, linear-lanceolate, acuminate, sinuous, stipitate, 30mm.–40mm. in length, 4mm.–6mm. in breadth, with distinct midrib and pinnate nerves, which extend two-thirds of the way to the margin. Sporophylls similar in type to the frond, 3mm.–4mm. in length, springing from both sides of the costa, solitary or fascicled, stipitate and provided with a distinct midrib but without lateral veins. The tetraspores are arranged longitudinally on either side of the costa. Cystocarps not seen.

I have deposited type specimens of the three above plants in the Canterbury Museum.

No list of Algæ from Macquarie Island, has, so far as I know, been published. With the plant above described, I received from Mr. Hamilton a number of other specimens, most of which were, however, too fragmentary for adequate determination. It may be of interest to note that there were amongst them, in addition to the above variety, *Ballia callitricha*, *Melobesia antarctica (?)*, *Plocamium*, 2 sp., *Polysiphonia*, sp., *Delesseria*, sp.

EXPLANATION OF PLATES XXVII. AND XXVIII.

Plate XXVII.

Delesseria crassinervia, Mont. (Photograph from Chatham Island specimen.)

Plate XXVIII.

Fig. 1. *Delesseria lancifolia*, var. *minor*, mihi, × 4 diam.
Fig. 2. *Delesseria linearis*, mihi, × 2 diam.
Fig. 3. Sporophylls—
(*a.*) *D. crassinervia*, × 15 diam.
(*b.*) *D. linearis*, × 15 diam.
(*c.*) *D. lancifolia*, var. *minor*, × 15 diam.

ART. XLI.—*New Zealand* Musci: *Notes on the Genus* Dicranum, *with Description of New Species, including Some Doubtful Species of* Blindia.

By ROBERT BROWN.

Plates XXIX.-XXXIV.

[*Read before the Philosophical Institute of Canterbury, 6th November, 1895*.]

I HAVE collected a large number of plants belonging to this genus in various districts in New Zealand, but I find that several of these have already been described in the "Handbook of the New Zealand Flora," which is still the standard work on this subject here. Some of those described there are not mentioned by me in this paper, for the simple reason that, up to the present time, I have seen no specimens thereof.

Among the new species here described are several of which I have been unable to obtain all those parts which are necessary to determine with certainty their generic character, hence it is possible some may ultimately have to be removed to other genera when all the details are available. For the present I have classified them under the present genus, that being, in my opinion, the one to which they have most affinity. This paper may also prove useful as a record of the existence of these plants in New Zealand at the present time, as, unfortunately, owing to climatic changes, advance of civilisation, and other causes, many species of the *Musci* are becoming rather rare, others have become quite extinct, and others are not found in those habitats where they formerly existed.

The peristomes in some of the new species will be found to be very curious and interesting, being irregularly bifid or trifid, and very irregularly perforated.

In the New Zealand species of this genus found by me I find three distinct characteristics in the leaves and two in the capsules; by means of either one or the other the genus might be conveniently subdivided—(1) Those species in which the leaves have broad sheathing-bases and the upper portion subulate; (2) those in which the leaves are secund and taper into long slender points, and have no sheathing-bases; (3) those in which the leaves are not secund, are more or less obtuse, and without sheathing-bases.

The subdivision I have preferred adopting is that based on the character and shape of the capsules, which gives a clear idea of their divergence from and relation to each other: 1st (Section A), those which have more or less ovate capsules; 2nd (Section B), those which have cylindrical capsules.

In the first section (Section A), of which *D. tasmanicum* is the typical plant, the capsules of the different species become differentiated from the type until they assume the wide mouth and turbinate form of the genus *Blindia.* Those specimens having this latter particular form of capsules are provisionally placed among the Dicranums, as, unfortunately, I have not been able to obtain all those parts which are necessary to accurately locate the species; but I note as a most important fact that some of them have the leaves, habit, and locale of *Dicranum* whilst possessing the capsules of *Blindia.*

I have had great difficulty in determining which genus to place some of the present mosses in, whether in *Dicranum* or *Blindia*, the differences between the two genera being so slight; the former having ovate to cylindrical capsules and the peristome united at the base, the latter having turbinate capsules, and in the peristome the teeth are free to the base.

In my own opinion it would be better to have added a new genus than to put mosses with ovate capsules into *Blindia;* but, as this has been done, and many of my plants touch closely on the border-land between the two genera, I have provisionally placed them all in the genus *Dicranum*, leaving their ultimate position to be decided when fuller and more correct information regarding these plants has been obtained.

In the "Transactions and Proceedings of the New Zealand Institute," vol. xxv., p. 298, Mr. Beckett has identified a moss, specimens of which were given to him by me, and collected near the Waimakariri glaciers—*D. rupestre* (*? Blindia*) of this paper—as *Blindia robusta*, Hampe, and has added a description of that moss. He is in error as to the identification. *Blindia robusta* is larger, the leaves are not so sharply secund nor so closely imbricating; the sheathing-base of the perichætial is longer, the capsule longer and narrower, but, above all, *B. robusta* is a monœcious plant, having the male inflorescence on separate branches, and its habitat in swampy ground, whilst *D. rupestre* is diœcious, and has its habitat on rocks.

He has also in the same publication—vol. xxvii., p. 403—identified *D. colinum* of this paper, found by me in Stewart Island, with *B. tenuifolia*, and has added a description of that moss. He has made some mistake here, for, on reference to his figures of *B. tenuifolia* (specimens of which he obtained from Mr. Weymouth, of Hobart) and mine of *D. colinum*, it will be seen they do not agree. I have not been able to make a comparison of *B. tenuifolia* with *D. colinum*, as I have never seen any specimen of the former.

I find one of the new species, *D. rostratum*, is very closely allied to *D. tasmanicum*, the leaves being apparently identical,

but on comparing the figures of their respective capsules and peristomes it will at once be seen that there is a great difference.

The moss which I have placed with some doubt as a variety of *D. gulliverii* was found by me in the Weka Pass in an imperfect condition, being overmatured (Pl. XXXI., fig. 15). The operculum given with this drawing was found in the middle of the tuft, as if it had fallen from the capsule and become imbedded there. It fitted exactly the mouth of the capsule, and I have completed the drawing by adding the doubtful operculum. If, on further details of this plant being found, it is shown I am right in placing this operculum and capsule together, the name *longirostrum* would apply to this moss with singular force. I know of no other moss to which this operculum could belong. The capsule of the variety differs from that of *D. gulliverii* in being considerably shorter and slightly broader.

With regard to the moss which I have placed as a variety of *D. tasmanicum*, I have only a very small quantity, as it was quite accidentally collected by me, along with some other mosses, at Paterson's Creek, Otarama, and was not discovered until my arrival at home.

In the second section (Section B), of which *D. billardierii* is the typical plant, are placed those species which have cylindric capsules. Most of these have already been described in the Handbook, but, as difficulty will be found in identifying those grown in high altitudes, owing in the first place to the want of sufficient illustrative drawings, and in the next place to the fact that the plants grown there and exposed to severe climatic influences, open situations, &c., are greatly reduced in size in comparison with those grown under more favourable circumstances, I have drawn these (already described) to the same scale as the other plants, and have pointed out what I consider their distinctive characters for the benefit of those that follow. These are marked with an asterisk.

The drawings accompanying this paper were all taken with a power of 25 diameters. As the distinctions between a very large number of these mosses are microscopic (as well as some of the plants themselves), any drawing much under this magnification would be practically useless for the purposes of comparison and identification.

SECTION A.

Capsules more or less ovate.

1. Dicranum pygmæum.
2. " pusillum.
3. " variabile.
4. " erecto-thecum.

5. Dicranum schreberi.*
6. " cockaynii.
7. " debilum.
8. " papillosum.
9. " subulatifolium.
10. " craigieburnensis
11. " tasmanicum.*
12. " " *var. β.?*
13. " lancifolium (Blindia ?).
14. " rostratum.
15. " gulliverii.
16. " " *var. β.?*
17. " clintonensis.
18. " rupestre.
20. " colinum (Blindia ?).

SECTION B.

Capsules cylindrical.

21. Dicranum billardierii.*
22. " speightii.
23. " fasciatum.*
24. " " *var. β.*
25. " robustum.*
26. " dicarpon.*
27. " setosum.*
28. " fulvum.
29. " menziesii.*
30. " " *var. β.*
31. " (?) obesifolium.

SECTION A.

1. **Dicranum pygmæum**, sp. nov.

Plants small, slender, gregarious, $\frac{3}{16}$in. high, yellowish-green. *Stems* nearly simple, branched by innovations. *Leaves* very small, inserted all round the stem, erecto-patent, slightly round, subulate, from a slightly broader base nerved to the apex. *Margins* entire, slightly concave. *Areola:* upper large, quadrangular; lower slightly larger, scarcely altered when dry. *Perichætial leaves* nearly erect, larger than the stem ones, slightly secund, subulate, from slightly broader base. *Margins* entire. *Nerve* continuous to the apex. *Fruitstalk* terminal, $\frac{1}{8}$in. long, nearly erect. *Capsule* small, ovate. *Mouth* wide. *Peristome* single, 16, bifid, united at the base. *Operculum* wide, oblique, conico-rostrate, slightly longer than the capsule. *Calyptra* cucullate, scarcely covering the operculum.

Hab. Damp calcareous rocks, Paterson's Creek, Otarama. Collected by R. B.; December, 1894.

2. Dicranum pusillum, sp. nov.

Plants small, slender, gregarious, growing in loose patches, yellowish-green, about $\frac{1}{4}$in. high. *Stems* nearly simple, branching by innovations. *Leaves* small, spreading, inserted all round the stem, upper ones secund, linear-lanceolate, tapering to a slender point, falcate. *Margins* entire, concave. *Nerve* continuous to the apex. *Areola* quadrate, larger below, nearly erect, slightly crisp when dry. *Perichætial leaves*, innermost nearly a half shorter than the outer, sheathing at the base, oblong, linear-lanceolate, tapering into a slender point, concave. *Margins* entire. *Nerve* continued to the apex. *Fruitstalk* terminal, erect, bright-red, from $\frac{3}{16}$in.–$\frac{5}{16}$in. long. *Capsule* small, erect, ovate. *Mouth* as wide as the capsule. *Peristome* single, 16, bifid for about one-third of the length, united at the base. *Operculum* oblique, conico-rostrate, as long as the capsule. *Calyptra* cucullate, reaching the base of the capsule.

Hab. Damp calcareous banks near Broken River. Collected by R. B.; March, 1891.

3. Dicranum variabile, sp. nov.

Plants small, growing in dense patches, $\frac{1}{4}$in. high, dark-green. *Stems* nearly simple, branched by innovations. *Leaves* small, inserted all round the stem, erecto-patent, subulate from a broad erect sheathing oblong or ovate base about half the length of the leaves, semi-convolute. *Margins* and back of the leaves papillose. *Nerve* concolorous, ending near the apex. *Upper areola* dense, quadrate; *lower* oblong. *Margins* and upper half of leaves incurved when dry. *Perichætial leaves* erect, otherwise similar in form and size to those in the middle and upper portion of the stem. *Fruitstalk* terminal, nearly erect, $\frac{3}{8}$in. long, bright-red. *Capsule* oblong-ovate, variable in size. *Peristome* 16, bifid to near the middle, and perforated. *Calyptra* cucullate.

Hab. Damp calcareous banks near Broken River. Collected by R. B.; March, 1891.

4. Dicranum erecto-thecum, sp. nov.

Plants growing in large dense patches, 1in.–1$\frac{1}{4}$in. high, pale-green above, nearly white below. *Stems* slender, erect, fragile, branching by innovations. *Branches* few, fastigiate. *Leaves* inserted all round. *Stems* erecto-patent, recurved or suberect, linear-lanceolate, obtuse, semi-convolute. *Margins* entire. *Nerve* ending below the apex. *Upper areola* small, dense. *Leaves* crisped when dry. *Perichætial leaves* erect, shorter and narrower than the upper ones, linear-lanceolate, obtuse, semi-convolute. *Margins* entire. *Nerve* ending below the apex. *Fruitstalk* terminal, $\frac{3}{8}$in. long, nearly erect, red. *Capsule* erect, narrow ovate. *Peristome* single, small,

16, irregularly bifid for one-third of their length, and irregularly perforated. *Operculum* oblique or nearly straight, stout, conico-rostrate, shorter than the capsule. *Calyptra* cucullate.

Hab. Limestone rocks, Weka Pass, Canterbury. Collected by R. B.; November, 1886.

This plant grows in situations similar to *D. tasmanicum*, and is rare.

5 **Dicranum schreberi,*** Hedwig, Handb. N.Z. Fl., p. 411.

6. **Dicranum cockaynii,** sp. nov.

Plants grown in dense patches, congested with brown fibrils below, darkish-green above, from ½in.–2in. high. *Stems* nearly simple, branching by innovations. *Branches* few, slender, erect. *Leaves* inserted all round, spreading or erecto-patent, flexuous, subulate from a broad erect oboval sheathing-base, about one-third of the length of the leaves, semi-convolute. *Nerve* scarcely discernible in the subulate portion, papillose on margins and back. *Upper areola* small, dense; *lower* oblong, crisped when dry. *Perichætial leaves* erect, subulate from a broad sheathing-base, papillose on the margins and backs. *Fruitstalk* terminal, ½in. long, red. *Capsules* ovate. *Peristome* single, 16, bifid for one-third of their length, united near the base. *Operculum* oblique, conico-rostrate, shorter than the capsule. *Calyptra* cucullate.

Hab. Limestone rocks, dripping with water, head-waters of the River Conway, near Palmer's Pass. Collected by R. B.; February, 1894.

7. **Dicranum debilum,** sp. nov.

Plants small, gregarious, yellowish, $\frac{3}{16}$in. high. *Stem* slender, sparsely branched. *Leaves* inserted all round the stem, erecto-patent, subulate from a broad erect sheathing-base half the length of the leaves, concave. *Margins* entire. *Nerve* ending below the apex. *Upper areola* oblong; *lower* slightly larger, erect when dry. *Perichætial leaves* erect, about the same size as the upper leaves and similar in all other respects. *Fruit* terminal. *Fruitstalk* $\frac{3}{16}$in. long, inclined. *Capsule* small elliptic. *Peristome* single, 16, bifid for one-third of their length, united at the base. *Operculum* very oblique, conico-rostrate, as long as the capsule. *Calyptra* not found.

Hab. Calcareous banks, Paterson's Creek, Otarama. Collected by R. B.; December, 1894.

8. **Dicranum papillosum,** sp. nov.

Plants growing large, in dense patches, yellowish-green above, from 1in.–1½in. high. *Stems* nearly simple, slender, congested with brown fibrils, branching by innovations.

Branches few. *Leaves* inserted all round the stem, erecto-patent, incurving, subulate from broad and sheathing base, which is widely dilated at the apex, semi-convolute; subulate portion of leaves about twice the length of the sheathing. *Margins* and back of leaves papillose. *Nerve* concolorous indistinct, ending below the apex. *Upper areola* small, dense; *lower* oblong, crisped when dry. *Perichætial leaves* erect, slightly larger than the stem ones, otherwise very similar to them *Fruitstalk* terminal, erect, red, ⅜in. long *Capsule* ovate, slightly oblique. *Peristome* single, irregular, 16, bifid or trifid, and perforated *Operculum* oblique, conico-rostrate, two-thirds the length of the capsule *Calyptra* cucullate

Hab. Limestone rocks, dripping with water, head-waters of the River Conway, near Palmer's Pass Collected by R. B

9. **Dicranum subulatifolium**, sp. nov.

Plants growing in large dense tufts, from 2in.–3in. high, yellowish-green above. *Stems* nearly simple, erect, congested with brown fibrils, branching by innovations *Branches* few, short. *Leaves* spreading or erecto-patent, incurving, inserted all around the stem, subulate from a broad sheathing oblong or obovate base; subulate portion of the leaves two and a half times the length of the sheathing-base, semi-convolute, papillose on the margins and back. *Nerve* concolorous indistinct, ending below the apex. *Upper areola* dense, small, quadrate; *lower* oblong, crisped when dry. *Perichætial leaves* slightly smaller than the upper ones, nearly erect, sheathing portion of the leaves longer and narrower than those of the stem, and the subulate portion shorter in proportion to them *Fruitstalk* terminal, erect, ½in long, red. *Capsule* elliptical, symmetrical. *Peristome* not seen. *Operculum* oblique, conico-rostrate, shorter than the capsule. *Calyptra* cucullate

Hab. Limestone rocks, dripping with water, head-waters of the River Conway.

10. **Dicranum craigieburnensis**, sp. nov.

Plants growing in tufts 2in. high, darkish-green. *Stems* nearly erect, sparingly branched by innovations. *Branches* few. *Leaves* inserted all round the stem, closely imbricating, erecto-patent or subsecund, lanceolate, tapering shortly into a long slender point, slightly concave. *Margins* entire. *Nerve* stout, ending at the apex, and nearly occupying all the upper portion of the leaf. *Upper areola* small, dense; *lower* oblong, crisped when dry. *Perichætial leaves* shorter than the stem ones, and the slender points shorter in proportion, innermost leaf smallest, ovate, lanceolate, with a slender point, nerved to the apex. *Fruit* terminal. *Fruitstalk* ½in. long, slightly flexuous. *Capsule* unequally ovate. *Peristome* single, 16,

irregularly perforated, and bifid or trifid. *Operculum* slightly oblique, conico-rostrate, longer than the capsule. *Calyptra* cucullate.

Hab. Wet limestone rocks, Cragieburn Range, near Castle Hill. Collected by R. B.; March, 1891.

11. **Dicranum tasmanicum,*** Hook. f., Handb. N.Z. Fl., p. 410.
Hab. On wet calcareous banks.

12. **Dicranum tasmanicum** (var. β.?)
Collected at Paterson's Creek, Otarama, by R. B.; January, 1895.

13. **Dicranum lancifolium (Blindia?),** sp. nov.

Plants growing in dense patches from ½in. to ¾in. high, brownish-green above, brown below. *Stems* erect, nearly simple, branching by innovations. *Branches* short, erect. *Leaves* small, inserted all round the stem, closely imbricating, erecto-patent or occasionally spreading, ovate or oblong-lanceolate, obtuse, semi-convolute. *Margins* entire, slightly incurved. *Nerve* ending close to the apex. *Areola* dense nearly to the base; near to the base the cells are oblong. *Leaves* nearly erect when dry. *Perichætial leaves* erect, narrower, not so concave as the stem ones, and about the same length. *Nerve* ending close to the apex. *Margins* entire. *Fruit* terminal. *Fruitstalk* erect, red, ⅜in. long, with a fine spiral twist. *Capsule* erect, sub-rotund. *Mouth* wide. *Peristome, operculum,* and *calyptra* not found.

Hab. Wet calcareous banks, Weka Pass. Collected by R. B.; March, 1893.

14. **Dicranum rostratum,** sp. nov.

Plants growing in dense patches from ½in. to 1in. high, green above, brown below. *Stems* fastigiately branched. *Branches* short, leaves inserted all round the stem, erecto-patent, oblong-lanceolate, obtuse or subacute, slightly recurved, very concave. *Margins* entire, nerve ending near the apex. *Areola* dense to near the base; close to the base they are oblong, crisped when dry. *Perichætial leaves* erect, ligulate, obtuse, slightly longer than the stem ones. *Nerve* ending below the apex, slightly concave. *Fruit* terminal. *Fruitstalk* erect, slightly flexuous, ⅜in. long. *Capsule* subrotund. *Mouth* wide. *Peristome* single, approximated in pairs, very irregularly bi- or tri-fid, and variously perforated. *Operculum* wide, conico-rostrate, twice the length of the capsule. *Calyptra* cucullate.

Hab. Limestone rocks in the bed of Paterson's Creek, Otarama. Collected by R. B.; January, 1895.

15. Dicranum gulliverii, sp. nov.

Plants growing in dense patches 1in.–1½in. high. *Stems* nearly simple, erect, branching by innovations. *Branches* few, slender, fastigiate. *Leaves* inserted all round the stem, imbricating, erecto-patent, straight, lower ones acicular, middle and upper ones ovate-lanceolate, tapering into a long slender point, longer than the lower portion. *Margins* entire. *Nerve* continuous, semi-convolute. *Areola* small, dense; *lower* oblong, without alar cells, nearly erect when dry. *Perichætial leaves* convolute, sheathing for two-thirds of their length, upper third subulate, nerved to the apex. *Fruit* terminal. *Fruitstalk* nearly erect or slightly flexuous, red, ¾in. long. *Capsule* ovate-oblong, slightly oblique, narrowing to the mouth. *Peristome* single, rather membranous, irregularly bifid, perforated or united. *Operculum* oblique, conico-rostrate, about half the length of the capsule. *Calyptra* cucullate.

Hab. Wet limestone rocks near Greymouth, West Coast. Collected by W. J. Gulliver; 1894. This plant is named after the finder.

16. **D. gulliverii**, var. β.?

17. **Dicranum clintonensis**, sp. nov.

Plants growing in tufts from ½in. high, brownish-green. *Stems* erect, branched by innovations. *Branches* fastigiate. *Leaves* inserted all round the stem, spreading from a short sheathing-base, then contracted into a stout subulate apex; upper portion of the leaf about one and a half times longer than the lower, semi-convolute. *Margins* serrated towards the apex. *Nerve* ending at the apex. *Upper areola* linear; *lower* oblong, crisped when dry. *Perichætial leaves* longer than the stem ones, with an erect, sheathing, convolute base, and the upper portion subulate, stout, spreading. *Margins* serrated towards the apex. *Nerve* continuous. *Fruit* terminal. *Fruitstalk* erect. *Capsule* broadly ovoid. *Mouth* wide. *Operculum* oblique, convexo-rostrate, as long as the capsule. *Calyptra* not found.

Hab. Rocks, Clinton Glen, head of Lake Te Anau. Collected by R. B.; January, 1889. The peristomes of this plant were all destroyed by insects before I had an opportunity of drawing them.

18. **Dicranum rupestre**, sp. nov.

Plants diœcious, growing in dense tufts 1½in. high, of a brownish-yellow or bronzy colour. *Stems* slender, fastigiately branched. *Branches* short. *Leaves* inserted all round the stems, strongly secund, circinate, middle ones shortly linear-lanceolate, tapering into a long slender point from four to five times longer than the base, sheathing, semi-convolute, upper

ones with a short subrotund base, tapering suddenly into a long slender point three and a half times longer than the sheathing-base, semi-convolute. *Margins* entire. *Nerve* continued to the apex, and occupying all the upper portion of the slender point. *Upper areola* small; *lower* narrow, oblong, unaltered when dry. *Perichætial leaves* smaller than the stem ones, innermost smallest, erect, with a large subrotund base, suddenly tapered into a slender point the same length as the base; outer one with a longer broadly oblong sheathing-base, tapering into a slender circinate point. *Nerve* continuous. *Fruit* terminal. *Fruitstalk* inclined, ⅝in. long, red. *Capsule* subrotund. *Mouth* wide. *Operculum* very oblique, convexo-rostrate, longer than the capsule. *Calyptra* cucullate. *Male inflorescence* gemmaceous at the apex of an unbranched stem.

Hab. On rocks, old moraine near Waimakariri glaciers. Collected by R. B.; February, 1889.

20. **Dicranum colinum (Blindia?)**, sp. nov.

Plants growing in large dense tufts 3in. to 4in. in diameter and from 2in. to 3in. high, very dark-brown, almost black, branched subfastigiately. *Branches* short. *Leaves* inserted all round the stem, very secund, falcate, middle ones with a short narrow ovate-lanceolate base, and a long slender point three or four times the length of the base; upper ones with a subrotund sheathing-base, suddenly tapered into a long slender point between three and four times longer than the base, concave. *Margins* entire. *Nerve* slender, continuous, occupying all the upper portion of the leaf. *Upper areola* linear; *lower* narrow, oblong, unaltered when dry. *Perichætial leaves* shorter than the stem ones, innermost ovate, with a short point, sheathing, outer base ovate, sheathing, tapered into a slender curved point two and a half times longer than the base, nerved to the apex. *Fruitstalk* terminal, stout, straight, ⅜in. long. *Capsule* erect, small, very short, turbinate or obcircinate, unaltered when dry. *Mouth* wide. *Peristome* imperfect, only the bases of broken teeth seen. *Operculum* wide, slightly oblique, conico-rostrate, one-third longer than the capsule. *Calyptra* not found.

Hab. Growing half-submerged in small tarn, along with a large, almost black *Hepatica*, on the summit of Thomson's Range, Stewart Island. Collected by R. B.

Section B.

Plants in which the Sheathing-bases of the Perichætial Leaves are long.

21. **Dicranum billardierii,*** Bridel, Handb. N.Z. Fl., p. 412.

In this species the capsule is gibbous, and the perichætial

leaves are very long, erect, sheathing the fruitstalk to near the middle, and ending in a short toothed hair-point.

22. **Dicranum speightii**, sp. nov.

Plants growing in cæspitose tufts, 2in.–2½in. high, fulvous, sparingly branched. *Branches* fastigiate. *Leaves* inserted all round the stem, subsecund or erect, lower narrow, oblong-lanceolate, tapering into a long slender convolute point toothed towards the apex, upper with a short subrotund base, shortly tapering into a long slender convolute point four times longer than the base, toothed towards the apex. *Nerve* continuous. *Upper areola* unaltered when dry. *Perichætial leaves* long, erect, convolute, sheathing, suddenly contracted into a very short toothed hair-point, outer leaf shorter than the inner one, the perichætial leaves being sheathed by several shorter ones, the sheaths of which become shorter and the slender points longer as they recede from the perichætial ones, until the sheathing-base is subrotund. *Fruit* acrocarpous. *Fruit-stalk* ¾in. long. *Capsule* subcylindric, tapering towards the fruitstalk. *Peristome* single, 16, bifid for one-third of their length. *Operculum* oblique, conico-rostrate, as long as the capsule. *Calyptra* cucullate.

Hab Rotten wood, head of the South Fiord, Lake Te Anau. Collected by R. B.; December, 1888: named after B. Speight, M.A., B.Sc., Hon. Sec., Canterbury Philosophical Institute.

23. **Dicranum fasciatum**,* Hedwig, Handb. N.Z. Fl., p. 412.

In this species the capsule is but slightly gibbous, and the perichætial leaves are very long, erect, sheathing all the fruitstalk, then tapering into a slender toothed point, which projects above the capsule.

24. **Dicranum fasciatum**, var. *β*.

This moss is smaller in all the leaves, and the peristome very irregularly bi- or tri-fid or cohering or irregularly perforated.

Hab. West Coast. Collected by R. B.

25. **Dicranum robustum**,* Hook. f. and Wils., Handb. N.Z. Fl., p. 411.

In this species the capsule is gibbous, the perichætial leaves are shorter than in the above species, erect, and sheathing the fruitstalk, ending in a short entire hair-point; and my specimens are nerveless.

26. **Dicranum dicarpon**,* Hornsch., Handb. N.Z. Fl., p. 411.

In this species the capsule is slightly gibbous, and the perichætial leaves are very wide, erect, generally sheathing two or

mere fruitstalks, nerveless or very indistinct, ending in an acute point or short hair-point.

Plants in which the Sheathing Portions of the Perichætial Leaves are short.

27. **Dicranum setosum,*** Hook. f. and Wils., Handb. N.Z. Fl., p. 412.

In this species the capsule is gibbous, the perichætial leaves are short, erect, sheathing for half of their length, then suddenly contracted into a toothed hair-point.

28. **Dicranum fulvum,** sp. nov.

Plants growing in tufts, fulvous, from 1¼in.–2in. high, subdichotomously branched, fastigiate. *Leaves* closely imbricating, and inserted all round the stem, secund, tapering into a long slender point, from a narrow ovate-lanceolate base, subconvolute, minutely toothed towards the apex. *Nerve* continued to the apex, occupying all the upper portion of the leaves. *Upper areola* small, subquadrate; *lower* linear, narrow-oblong, scarcely altered when dry. *Perichætial leaves* half as long as the upper ones, lower half erect, convolute, sheathing, upper half shortly tapering into a slender hair-point *Fruit* terminal. *Fruitstalk* short, ½in. long. *Capsule* inclined, ovate-oblong. *Mouth* as wide as the capsule. *Peristome* single, 16, bifid about a third of their length, the bifid portion unfolded, and remains so, wet or dry. *Operculum* not found. Calyptra cucullate.

Hab. Bush, West Oxford. Collected by R. B.; 1885.

29. **Dicranum menziesii,*** Taylor, Handbook N.Z. Fl., p. 412.

There is a clerical error in the Handbook description of this moss; it is described as "serrated at the base" instead of "at the apex." The perichætial leaves are shorter than those of *setosum*.

30. **Dicranum menziesii, var. β.**

The capsule is more slender, and the operculum not so oblique. The sheathing-base of the inner perichætial leaf is also much longer.

31. **Dicranum (?) obesifolium,** sp. nov.

Plants growing in tufts, pale-yellow, 5in. to 6in. high, subdichotomously branched. *Leaves* inserted all round the stem, spreading or erecto-patent, broadly ovate-lanceolate, obtuse, convolute, cucullate at the apex. *Margins* entire, nerved.

Hab. Rocky places, Kelly's Hill, Westland. Collected by R. B. I have only collected two specimens of this moss at

widely separated distances apart. Both of these were barren. It seems to be rare. It has the habit and appearance of *Dicranum*.

EXPLANATION OF PLATES XXIX.-XXXIV.

PLATE XXIX.

Fig. 1.—*Dicranum pygmaeum.*

1. Capsule.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Stem leaves.
5. Operculum.
6. Calyptra.
7. Peristome.

Fig. 2.—*Dicranum pusillum.*

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Peristome.
5. Stem leaves.
6. Calyptra.

Fig. 3.—*Dicranum variabile.*

1, 1A. Variable capsules.
2. Perichætial leaves.
3. Outside perichætial leaves.
4. Stem leaves.
5. Peristome.
6. Calyptra.

Fig. 4.—*Dicranum erecto-thecum.*

1. Capsule, with operculum.
2. Perichætial leaves.
3. Outside perichætial leaves.
4, 5. Stem leaves.
6. Calyptra.

Fig. 5.—*Dicranum schreberi.*

1. Capsule, with operculum.
2. Perichætial leaves.
3. Outside perichætial leaves.
4. Stem leaf.
5. Calyptra.
6. Peristome.

Fig. 6.—*Dicranum cockaynii.*

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside perichætial leaves.
5. Stem leaf.
6. Peristome.

PLATE XXX.

Fig. 7.—*Dicranum debilum.*

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside perichætial leaf.
5. Upper stem leaf.
6. Lower stem leaves.
7. Peristome.

Fig. 8.—*Dicranum papillosum.*

1. Capsule and operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside perichætial leaf.
5. Stem leaves.
6. Peristome.

Fig. 9.—*Dicranum subulatifolium.*

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside perichætial leaf.
5. Stem leaf.
6. Calyptra.

Fig. 10.—*Dicranum craigieburnensis*

1. Capsule and operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside perichætial leaf.
5. Stem leaves.
6. Calyptra.

Fig. 11.—*Dicranum tasmanicum.*

1. Capsule and operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Stem leaves.
5. Peristome.

Fig. 12.—*Dicranum tasmanicum,* var. β.?

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Stem leaves.

Plate XXXI.

Fig. 13.—*Dicranum lancifolium.*

1. Capsule.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside perichætial leaf.
5. Stem leaves.

Fig. 14.—*Dicranum rostratum.*

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Upper stem leaf.
5. Middle stem leaf.
6. Calyptra.
7. Variable teeth of peristome.

Fig. 15.—*Dicranum gulliverii.*

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside perichætial leaf.
5. Lower stem leaves.
6. Middle stem leaf.
7. Upper stem leaf.
8. Calyptra.
9. Peristome.

Fig. 16.—*Dicranum gulliverii*, var β.?

1. Capsule, with doubtful operculum.
2. Inner perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaf.
5. Operculum.

Fig. 17.—*Dicranum clintonensis.*

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Upper stem leaves.
5. Middle stem leaves.

Fig. 18.—*Dicranum rupestre.*

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside perichætial leaf.
5. Stem leaf.
6. Calyptra.

Plate XXXII.

Fig. 19.—*Blindia robusta.*

1. Capsule and operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside perichætial leaf.
5. Stem leaves.

Fig. 20.—*Dicranum colinum* (*Blindia*?).

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside perichætial leaf.
5. Stem leaves.
6. Operculum.

Fig. 21.—*Dicranum billardierii.*

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outside perichætial leaf.
4. Stem leaf.
5. Peristome.

Fig. 22.—*Dicranum speightii.*

1. Capsule and operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside perichætial leaf.
5. Upper stem leaf.
6. Middle stem leaf.

Fig. 23.—*Dicranum fasciatum.*

1. Capsule and operculum.
2. Inner perichætial leaf.
3. Outside perichætial leaf.
4. Stem leaves.
5. Peristome.

Plate XXXIII.

Fig. 24.—*Dicranum fasciatum*, var. β.

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outside perichætial leaf.
4. Stem leaves.
5. Peristome.

Fig. 25.—*Dicranum robustum.*

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outside perichætial leaf.
4. Stem leaves.

Plate XXXIII.—*continued.*

Fig. 26.—*Dicranum dicarpon.*

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outside perichætial leaf.
4. Stem leaves.
5. Peristome.

Fig. 27.—*Dicranum setosum.*

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside perichætial leaf.
5. Stem leaves.
6. Peristome.

Plate XXXIV.

Fig. 28.—*Dicranum fulvum.*

1. Capsule.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside perichætial leaf.
5. Stem leaves.
6. Calyptra.

Fig. 29.—*Dicranum mensiesii.*

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside perichætial leaves.
5. Stem leaves.
6. Peristome.

Fig. 30.—*Dicranum mensiesii,* var. *β.*

1. Capsule, with operculum.
2. Inner perichætial leaf.
3. Outer perichætial leaf.
4. Outside perichætial leaf.
5. Stem leaves.
6. Calyptra.

Fig. 31.—*Dicranum* (?) *obesifolium.* Stem leaves.

Art. XLII.—*Notes on the New Zealand* Musci, *and Descriptions of New Species.*

By Robert Brown.

[Read before the Philosophical Institution of Canterbury, 18th July, 1896.]

Plates XXXV.-XXXVIII.

Genus Campylopus.

The species belonging to this genus are easily recognised by their erect, densely-tufted habit, the upper half of the fruitstalk being hygrometric, moving up or down according to the amount of moisture by which the plants are surrounded; they also have very broad lamellated nerves; their peristomes are bifid in the upper part and united below; the calyptra is cucullate, and almost invariably fringed at the base with cilia. They flourish luxuriantly in damp or wet situations, in the crevices of rocks, on marshy ground, and on wet rotten wood or other decaying vegetable matter.

This genus is well represented on Stewart Island, especially on Mr. Walker's run, which is a low marshy valley that extends from Paterson's Inlet to Mason's Bay and Ruggedy

Isles on the western side of the island. Another prolific locality is on the property of Mr. Traill, Waterfall Run, at the head of the inlet, where a considerable portion of the vegetation is made up of these small plants, especially near the water.

I have found great difficulty in arriving at the determination of the different plants of this genus from the want of sufficiently-identified species, and also from the extreme paucity of the descriptions of some of the *Campylopi* described in the "Handbook of the New Zealand Flora," where Sir W. Hooker remarks "that the New Zealand species are far from being satisfactorily determined, owing to the want of good specimens, and the different views of authors."

Since that time very little has been done to improve this very unsatisfactory position—in fact, I am only aware of one species having been added to the list—viz., *C kirkii.* I have, unfortunately, only a very small barren piece of this moss, which I received from Mr. Kirk himself, so I am even unable to satisfactorily identify the plant.

I have given figures of all the species of this genus which have come under my notice with the exception of *C. kirkii,* which has already been figured by Mr. Beckett in vol. xxvi., "Transactions and Proceedings of the New Zealand Institute." The leaves of the different mosses that I have drawn are taken from the same parts of each plant of this very difficult genus. The figures are also drawn to one scale for facility of comparison, &c.

1. *C. introflexus*, Hedwig, Handbk. N.Z. Fl., p. 414.

An extremely common plant in New Zealand, and has a large number of varieties, some of them differing so much in appearance and in the size of the capsule that there is often great difficulty in identification.

2. *C. appressifolius*, Mitten, Handbk. N.Z. Fl., p. 414.

I have been unable to identify this plant. This may have resulted from the great similarity existing in the leaves of a great many different species of this genus. This is accentuated by the unfortunate fact that the capsule of this moss is not described in the "Handbook of the New Zealand Flora," which is apparently the only authority on this matter. It is a matter for regret that descriptions are not always accompanied with authentic drawings, as a considerable amount of time and labour would be saved. My own impression, from reading the remarks attached to the description of *C. clavatus*, Brown, in the above-mentioned work, is that *C. appressifolius* is intermediate between *C. clavatus* and *C. introflexus*, and may possibly be one of the many varieties of *C. introflexus*.

3. *C. clavatus*, Brown, Handbk. N.Z. Fl., p. 414.

I have only seen one specimen of this moss, which was collected by Mr. Petrie in Otago, and agrees very well with the description in the Handbook. My figures are drawn from his specimens.

4. *C. sparksii*, n.s.

Plants diœcious, growing in loose patches, 1½in. high, slender, yellowish-green at the apex, brown below. *Stem* simple or dichotomously branched. *Branches* aggregated, arising from the gemmiform apex of the stem, one or two innovations continuing the stem, the other ones being short fruiting-branches. *Leaves* inserted all round the stem, flexuous or subsecund, lower ones small, tapering from the base into a slender point; upper ones long, tapering from an oblong base into a long slender point, toothed near the apex, convolute. *Nerves* broad, lanceolate. *Areola* linear-oblong. *Leaves* unaltered when dry. *Leaves on fruiting-branch:* lower small convolute; perichætial convolute, sheathing, tapering from an oblong base into a long slender toothed point. *Nerves* narrow. *Fruit* terminal. *Seta* hygrometric, from the middle upwards ½ to ⅔ decurved when moist, erect and spirally twisted when dry. *Capsule* elliptic, tapering into the fruitstalk. *Operculum* stout, oblique, conico-rostrate. *Peristome* single, 16, united at the base, bifid; lower half dome-shaped, upper half erect and slightly cohering at the tips. *Calyptra* cucullate, fringed with cilia at the base.

Hab. Wet base of tussocks, Horse-shoe Lake, near Christchurch; March, 1883. Collected by R. B.

5. *C. torquatus*, Mitten, Handbk. N.Z. Fl. p. 414.

This plant, although not so common as *C. introflexus*, is to be found all over New Zealand.

6. *C cockaynii*, n.s.

Plants diœcious, growing in tufts, yellowish above, dark-brown below, 1in. to 2in. high. *Stems* simple, or branched, gemmiform at the apex. *Branches* aggregated at the apex, one or two of them are innovations containing the stem, the other ones being short fruiting-branches. *Leaves* inserted all round the stem, imbricating, semi-convolute, middle and upper ones very similar, ovate-lanceolate, tapered into a subulate point. *Nerve* broad, lanceolate, erect, and adpressed when dry. *Fruiting-branch leaves:* lower and middle oblong, shortly tapering into a hair-point; upper oblong-lanceolate, tapering into a hair-point; perichætial, cylindric, sheathing, suddenly contracted into a hair-point. *Fruit* terminal. *Fruitstalk* hygrometric above the middle, flexuous, and decurved when

moist, erect and sparsely twisted when dry. *Capsule* ovate, symmetrical. *Operculum* oblique, conico-rostrate, beak slender. *Peristome* single, 16, bifid to the middle; lower half incurved, upper erect. *Calyptra* cucullate, fringed at the base with cilia.

Hab. Marshy ground, Stewart Island; March, 1892. Collected by R. B.

7. *C. traillii*, n.s.

Plants diœcious, growing in dense tufts, yellowish above, dark-brown below, 1in. to 2in. high. *Stems* simple or branched, gemmiform at the apex. *Branches* aggregated at the apex; one or two are innovations, which continue the stem, the others being short branches bearing the fruit. *Leaves* inserted all round the stem, imbricating, semi-convolute, middle ones linear-lanceolate, tapering into a hyaline hair-point, entire or minutely toothed, nearly occupying all the leaf; upper shorter, lanceolate, shortly tapering into a hyaline point. *Nerve* broad, lanceolate, erect when dry. *Fruiting-branch leaves*: lower and middle linear-lanceolate, tapering into a hair-point half the length of the leaf; upper, oblong, suddenly contracted into a hair-point; perichætial narrow, cylindric, sheathing contracted into an acuminate point, hyaline at the apex. *Fruit* terminal. *Fruitstalk* hygrometric above the middle, flexuous and decurved when moist, erect and spirally twisted when dry. *Capsule* ovate, symmetrical. *Operculum* short, conico-rostrate, oblique. *Peristome* single, 16, bifid, lower half incurved, upper erect, united at the base. *Calyptra* fringed at the base with cilia.

Hab. Marshy ground, Stewart Island; March, 1892. Collected by R. B.

8. *C. searellii*, n.s.

Plants diœcious, growing in dense tufts, golden-yellow above, brown below, 2in. to 4in. high. *Stems* radiculose, simple or branched, gemmiform at the apex. *Branches* aggregated at the apex; one or two of them are innovations, which continue the stem, the other ones being short branches bearing fruit, their number being variable. *Leaves* inserted all round the stem, erecto-patent, semi-convolute; middle ones linear-lanceolate, tapered into a hair-point; upper about the same length, ovate-lanceolate, tapered into a stouter hair-point, with a few teeth on the apex. *Nerve* broad, lamellated, erect when dry. *Areola* oblong. *Leaves on the fruiting-branches* semi-convolute, lower linear-lanceolate, middle oval-lanceolate, all tapered into a hair-point; upper ones oblong-lanceolate, tapering into a hair-point, slightly toothed on the apex; perichætial cylindric, sheathing, tapered shortly into a hair-point, inner one short. *Fruit* terminal. *Fruitstalk*

hygrometric above the middle, flexuous and decurved when moist, erect and spirally twisted when dry. *Capsule* elliptic. *Operculum* narrow, oblique, conico-rostrate. *Peristome* single, 16, bifid three-quarters of their length, united at the base, lower portion incurving, upper erect. *Calyptra* cucullate, fringed at the base with cilia.

Hab. Otira Gorge; December, 1887. Collected by R. B.

Var. *β*. Stems more slender, and the hair-points of the fruiting-branch leaves nearly one-half longer.

Hab. West Coast, near Greymouth. Collected by W. J. Gulliver, 1895, on very wet ground.

9. *C. bellii*, n.s.

Plants diœcious, growing in dense tufts, brownish-yellow above, brown below, ½in. to ¾in. high. *Stems* simple or branched, gemmiform at the apex. *Branches* aggregated at the apex; one or two of them are innovations continuing the stem, the others being short branches bearing the fruit, *Leaves* inserted all round the stem, imbricating, erecto-patent, semi-convolute; middle ones small, narrow, shortly oblong-lanceolate, tapered into a hair-point, double the length of the lower portion; upper ones ovate-lanceolate, tapering into a long hair-point, hyaline, and minutely toothed at the apex. *Nerve* broad, lamellate, erect when dry. *Areola* small, quadrate. *Leaves of fruiting-branches* small, tapering from a short ovate base into a hair-point, two and a half times longer than the base, hyaline at the apex; upper oblong, tapered into a hair-point, hyaline at the apex; perichætial cylindric, sheathing, tapering into a hair-point, hyaline at apex. *Fruit* terminal. *Fruitstalk* hygrometric above the middle, flexuous and decurved when moist, erect and spirally twisted when dry. *Capsule* pyriform. *Operculum* oblique, conico-rostrate for two-thirds of capsule. *Peristome* single, bifid, incurved in the lower half, erect in the upper. *Calyptra* cucullate, fringed at the apex with cilia.

Hab. Lake Te Anau, among decaying *Sphagnum;* January, 1890. Collected by R. B.

10. *C. walkerii*, n.s.

Plants diœcious, growing in dense tufts, ½in. to 1½in. high, yellowish at the apex, almost black below. *Stems* simple or branched, gemmiform at the apex. *Branches* aggregated, arising from the apex; one or two are innovations continuing the stem, the others being short fruiting-branches, variable in their number. *Leaves* inserted all round the stem, erecto-patent; middle ones oblong-lanceolate, acute; upper, lanceolate, tapered into an obtuse hyaline apex, semi-convolute. *Margins* entire. *Nerve* broad, lanceolate, erect, and adpressed

when dry. *Fruiting-branch leaves:* lower and middle oblong-lanceolate, tapered into a hair-point, hyaline at the apex; upper oblong, tapered into a hair-point, convolute, sheathing; perichætial longest, cylindric, tapered into a hair-point, hyaline at the apex. *Fruit* terminal. Upper half of *fruitstalk* hygrometric, flexuous, and decurved when moist, erect and spirally twisted when dry. *Capsule* subpyriform. *Operculum* oblique, conico-rostrate, about half the length of the capsule. *Peristome* single, 16, perforated, lower half incurved, upper erect, united at the base. *Calyptra* cucullate, fringed at the base with cilia.

Hab. Marshy ground, Stewart Island; March, 1892. Collected by R. B.

11. *C. rarus*, n.s.

Plants diœcious, growing in dense patches from 1in. to 3½in. high, dull yellowish-green above, pale-brown below. *Stems* slender, simple or branched, gemmiform at the apex. *Branches* aggregated, arising from the apex; one or two of them are innovations continuing the stems, the others being short branches bearing the fruit, variable in number. *Leaves* inserted all round the stem, imbricating, erecto-patent, straight, semi-convolute; middle ones linear-lanceolate, acute; upper shorter and broader, similar in outline to the middle ones. *Margins* entire. *Nerve* broad, lamellate, erect and adpressed when dry *Fruiting-branch leaves:* lower and middle oblong-lanceolate, tapered into a hair-point, about half the length; upper larger, oblong, tapered into a short point, semi-convolute; perichætial cylindric, erect, sheathing, with an acuminate point. *Fruit* terminal. Upper half of *fruitstalk* hygrometric, flexuous and decurved when moist, erect and spirally twisted when dry. *Capsule* ovate. *Mouth* slightly oblique. *Operculum* not found. *Peristome* single, 16, bifid to the middle, united at the base. *Calyptra* not found.

Hab. On marshy ground, near Lake Te Anau; January, 1890. Collected by R. B.

12. *C. ohingaitii*, n.s.

Plants diœcious, growing in loose tufts about 1in. high, pale-green above, brown below. *Stems* simple or dichotomous, slightly gemmiform at the apex. *Branches* aggregated, arising from the apex, one or two being innovations, the others being short and fertile, variable in number. *Leaves* imbricating all round, secund, semi-convolute; middle ones shortly oblong-lanceolate, tapering into a slender minutely-toothed point, about twice the length of the lower portion; upper ones with a short ovate base, tapering into a slender point, minutely toothed, three times the length of the base. *Nerve* lamellate, and occupying one-third of the breadth,

scarcely altered when dry. *Areola* quadrate. *Leaves, fruiting:* lower and middle having a short erect sheathing-base, tapering into a long, slender, curved hair-point four times longer than the base; upper ones sheathing, base oblong, tapering into a long hair-point; perichætial slender, sheathing, cylindric, suddenly tapered into a long, slender, flexuous hair-point, entire or minutely toothed. *Fruit* terminal. *Fruitstalk* hygrometric above the middle, decurved when moist, erect and spirally twisted when dry. *Capsule* ovate. *Peristome* single, 16, bifid, united at the base; lower half incurved, upper erect. *Operculum* not found. *Calyptra* fringed with cilia at the base.

Hab. Decayed wood, bed of River Otahapi, a tributary of the Rangitikei, North Island, N.Z. Collected by R. B.

13. *C. bicolor*, Hornsch., Handbk. N.Z. Fl., p. 415.

I have received authentic specimens of this plant collected by Dr. Boor, in Golden Bay, in the Province of Nelson. Mr. W. A. Weymouth has also sent me some Tasmanian specimens of this moss, authenticated by Dr. Brotherus, of Helsingfors, which are identical with the Nelson specimens, and also with specimens collected by me in Stewart Island, March, 1892. Among those then collected were several varieties of this species, one of the most distinct of them being twice as stout as *C. bicolor*, strongly resembling *C. kirkii*, Mitten. I have named this particular variety *C. intermedia*, to distinguish it from a much stouter variety, which is from four to five times stouter than *C. bicolor*. The drawings given of *C. bicolor* are taken from Dr. Boor's specimens. It appears to be very local.

Amended description.—*Plants* diœcious, growing in dense tufts, 2in. to 3½in. high, yellow at the apex, dark-brown below. *Stems* slender, simple or branched, gemmiform at the apex. *Branches* aggregated at the apex; one or two of them are innovations continuing the stem, the others being short branches bearing the fruit. *Leaves* inserted all round the stem, erect or erecto-patent, imbricating; middle ones linear-lanceolate, obtuse; upper larger, oblong-lanceolate, obtuse. *Nerve* one-third of the breadth, lamellate, semi-convolute, adpressed when dry. *Fruiting-branch leaves:* lower and middle ones shortly oblong-lanceolate, tapered into a hair-point, half of the length; upper larger, similar in outline, nerves narrow; perichætial cylindric, sheathing, shortly tapered into a short subacute point. *Fruit* terminal. *Fruitstalk* hygrometric above the middle, flexuous, and decurved when moist, erect and spirally twisted when dry. *Capsule* ovate, symmetrical. *Operculum* oblique, conico-

rostrate. *Peristome* single, 16, bifid above, united below *Calyptra* cucullate, fringed at the base with cilia.

Hab. Golden Bay, Nelson: collected by Dr. Boor. Stewart Island, in marshy ground; March, 1892: R. B.

Var. *β intermedia.* Stems twice as stout as *bicolor.*

Var. *γ.* Stems very stout, from four to five times stouter than *bicolor.* There was only one capsule found on this variety, which was slightly damaged. Collected by R. B.

15. *C. stewartii*, n.s.

Plants growing in very dense patches, from 2in. to 3½in. high, yellowish-green above, dark-brown below. *Stems* flexuous, erect, simple. *Leaves* imbricating all round the stem, nearly erect, oblong-lanceolate, obtuse, concave, cucullate at the apex. *Nerve* very broad, lanceolate, continued to the apex. *Margins* entire, erect, and adpressed when dry. *Areola* small, trapezoid. *Fruit* not found.

Hab. On the ground, summit of Mount Thomson, Stewart Island; March, 1892. Collected by R. B.

16. *C. gulliverii*, n.s.

Plants diœcious, growing in dense tufts, 1½in. to 2in. high, pale-green. *Stems* slender, simple or dichotomously branched, gemmiform at the apex. *Branches* aggregated, arising from the apex, one or two of them, being innovations, in continuation of the stem, the others being short branches bearing the fruit. *Leaves* small, inserted all round the stem, loosely imbricating, spreading or incurved; middle ones with a short ovate base, shortly tapered into a slender hair-point, three times the length of the base; upper ones shortly oblong, tapered into a slender point, base sheathing. *Nerve* one-third of the breadth, lamellate, scarcely altered when dry. *Areola* small, oblong. *Fruiting-branch leaves:* lower ones, base shortly ovoid, tapering into a slender hair-point, three to four times longer than the base; middle, obovate, suddenly rounded into a hair-point, four times longer than the base; upper, longer, oblong, rounded into a hair-point, three and a half times longer than the base, sheathing; perichætial cylindric, sheathing the fruitstalk, suddenly contracted into a slender hair-point, two and a half to three times the length of the lower portion. *Fruit* terminal. *Fruitstalk* $\frac{3}{16}$in. long, hygrometric from the middle upwards, flexuous and decurved when moist, erect and spirally twisted when dry. *Capsule* narrow, ovate-oblong, narrowed to the mouth. *Operculum* oblique, subulate two-thirds the length of the capsule. *Peristome*, 16, single, bifid, lower half incurved, upper half erect, united at the base. *Calyptra* not fringed at the base with cilia.

Hab. Wet places, near Greymouth, West Coast; 1896. Collected by W. J. Gulliver.

17. *C. cylindricothecum*, n.s.

Plants diœcious, growing in dense tufts, about 1in. high, yellow above, brown below. *Stems* nearly simple, slender, subgemmiform at the apex. *Branches* aggregated, arising from the apex; one or two of them are innovations continuing the stem, the others are short branches bearing the fruit, variable in number. *Leaves* inserted all round the stem, subsecund or erecto-patent; middle ones oblong-lanceolate, tapered into a long slender hair-point, entire or slightly toothed; upper broader, ovate-lanceolate, tapering into a hair-point. *Nerve* broad, lamellate, semi-convolute, erect when dry. *Areola* oblong, small. *Fruiting-branch leaves:* lower ones linear-lanceolate, tapered into a hair-point; middle oblong, suddenly contracted into a hair-point, longer than the lower portion; upper larger, but otherwise similar; perichætial leaves, lower half cylindric, sheathing, tapering into a slender hair-point, minutely toothed. *Fruit* terminal. *Fruitstalk* $\frac{5}{16}$in. long; upper half hygrometric, flexuous and decurved when moist, erect and spirally twisted when dry. *Capsule* cylindric, narrowed at the base, which is minutely scabrid. *Operculum* straight, narrow, conico-rostrate, one and a half times shorter than the capsule. *Peristome* single, 16, bifid, united at the base, incurved below, erect above. *Calyptra* cucullate, fringed at the base with cilia.

Hab. Wet turfy soil, near the Bealey; February, 1889. Collected by R. B.

18. *C. ellipticothecum*, n.s.

Plants diœcious, growing in dense patches from 1in. to 4in. high, yellow above, brown below. *Stems* radiculose. *Branches* barren and fertile, aggregated in the gemmiform apex of the stem, fertile ones very short, barren ones from $\frac{3}{8}$in. to 1in. long; one or two forming the continuation of the stem, which in turn become gemmiform previous to fruiting, which gives the plants a knotted appearance. *Leaves* imbricating all round the stem, slightly secund, nearly erect below, erecto-patent at the apex; middle stem ones oblong-lanceolate, tapering into a long slender point, entire or minutely toothed at the apex; upper ones broader but otherwise similar. *Nerve* broad, plaited, occupying all the upper portion of the leaf, concave, radiculose at the base. *Areola* small, trapezoid, alar ones large, unaltered when dry. *Fruiting-branch leaves* small, base oblong, tapering into a long slender point, base sheathing, nerve broad; perichætial leaves convolute, sheathing the fruitstalk, then tapering into a long, slender, curved point, inner one largest. *Fruit* terminal. *Fruitstalk* long, hygrometric in the middle, flexuous and decurved when moist, erect and spirally twisted when dry. *Capsule* cylindric,

scabrid at the base, slightly narrowed towards the mouth. *Operculum* nearly straight, shortly conic, tapering into a slender beak two-thirds the length of the capsule. *Peristome* single. *Calyptra* cucullate, ciliated at the base.

Hab. Marshy ground, Stewart Island; March, 1892. Collected by R. B.

19. *C. arcuatus*, n.s.

Plants diœcious, growing in dense tufts, 1in. to 2in. high, yellow above, brown below. *Stems* nearly simple, slightly gemmiform at the apex. *Branches* aggregated, arising from the apex; one, and sometimes two, being innovations continuing the stem, the others being short branches bearing the fruit, variable in number. *Leaves* inserted all round the stem, imbricating, straight erecto-patent; middle ones small, linear-lanceolate, tapering into a slender hair-point, hyaline and slightly toothed at the apex; upper small, shortly ovate-lanceolate, tapered into a short point, hyaline at the toothed apex. *Nerve* broad, lamellate. *Leaves* erect when dry. *Areola* small, linear. *Fruiting-branch leaves:* lower very small; middle ones large, shortly ovate, tapering into a slender hair-point; upper larger, but similar in outline, hyaline, and toothed at the apex; perichætial longest, cylindric, tapering into a long slender hair-point, hyaline, slightly toothed at the apex. *Fruit* terminal, solitary. *Fruitstalk* hygrometric from the middle upwards, flexuous and decurved when moist, erect and spirally twisted when dry. *Capsule* small, oblique, cylindric. *Operculum* oblique, narrow, subulate, half the length of the capsule. *Peristome* imperfect, single, 16, united at the base. *Calyptra* cucullate, fringed at the base with cilia.

Hab. Marshy ground, Stewart Island; March, 1892. Collected by R. B.

20. *C. otaramaii*, n.s.

Plants diœcious, growing in dense patches, 1in. to 2¼in. high, green above, brown below. *Stems* simple or dichotomously branched, gemmiform at the apex. *Branches* aggregated, arising from the apex; one or two of them being innovations continuing the stem, the others being short branches bearing the fruit. *Leaves* inserted all round the stem, imbricating, erecto-patent or spreading, semi-convolute; middle stem leaves subulate, tapered into a hair-point, hyaline at the apex, and slightly toothed; upper, shortly oblong-lanceolate, tapering into a long hair-point, hyaline, and slightly toothed at the apex. *Nerve* broad, lamellate. *Leaves* flexuous when dry. *Areola* small, oblong. *Fruiting-branch leaves:* lower and middle shorter, oblong-lanceolate, tapered into a long hair-point, hyaline, and slightly toothed; upper, oblong,

shortly tapered into a long hair-point, semi-convolute; perichætial, cylindric, sheathing, tapered into a hair-point, hyaline, and slightly toothed at apex. *Fruit* terminal, solitary. Upper half of *fruitstalk* hygrometric, flexuous and decurved when moist, erect and spirally twisted when dry. *Capsule* narrow, cylindric, narrowed towards the base. *Operculum* subulate, two-thirds the length of the capsule. *Peristome* single, 16, bifid, united at the base, lower half incurved, upper half erect. *Calyptra* cucullate, fringed at the base with cilia.

Hab. North side of Mount Torlesse, near Otarama, on wet clay banks; March, 1896. Collected by R. B.

21. *C. arenarius*, n.s.

Plants diœcious, growing in dense patches, ¼in. to ⅜in. high, yellow above, brown below. *Stems* simple or branched, gemmiform at the apex. *Branches* aggregated at the apex; one or two are innovations continuing the stem, the others are short, bearing the fruit, variable in number. *Leaves* small, inserted all round the stem, semi-convolute; middle ones narrow, linear-lanceolate, tapering into a very slender hair-point, shortly hyaline, and with a few minute teeth at the apex; upper, ovate, lanceolate, tapering into a slender hair-point, shortly hyaline. *Nerve* broad, lamellate, flexuous when dry. *Areola* oblong. *Fruiting-branch leaves* small, convolute; lower, subulate, tapered into a hair-point; middle, shortly oblong-lanceolate; upper, longer, tapering into a long slender hair-point, shortly hyaline at the apex; perichætial, cylindric, sheathing, tapering into a long slender point. *Fruit* terminal. *Fruitstalk* ⅜in. long; upper half hygrometric, flexuous and decurved when moist, erect and spirally twisted when dry. *Capsule* small, subcylindric. *Operculum* subulate, oblique, nearly two-thirds the length of the capsule. *Peristomes* all destroyed. *Calyptra* cucullate, fringed at the base with cilia.

Hab. Wet sand, Stewart Island, March, 1892. Collected by R. B.

Key to Species.

1. Campylopus introflexus, *Hedw.*
2. „ appressifolius, *Mitten.*
3. „ clavatus, *Brown.*
4. „ sparksii, *n.s.*
5. „ torquatus, *Mitten.*
6. „ cockaynii, *n.s.*
7. „ traillii, *n.s.*
8. „ searellii, *n.s.*
9. „ bellii, *n.s.*
10. „ walkerii, *n.s.*
11. „ rarus, *n.s.*
12. „ ohingaitii, *n.s.*
13. „ bicolor, *Hornschuch.*
14. „ kirkii, *Mitten.*

15. Campylopus stewartii, *n.s.*
16. " gulliverii, *n.s.*
17. " cylindricotheceum, *n.s.*
18. " ellipticotheceum, *n.s.*
19. " arcuatus, *n.s.*
20. " otaramaii, *n.s.*
21. " arenarius, *n.s.*

EXPLANATION OF PLATES XXXV.-XXXVIII.

Plate XXXV.

Fig. 1.—*Campylopus introflexus*, Hedw. (one of its forms).

1. Perichætial leaf.
2. Upper branch leaf (fruiting).
3. Middle branch leaf (fruiting).
4. Middle stem leaf.
5. Upper stem leaf.
6. Capsule.
7. Peristome.
8. Calyptra.

Fig. 3.—*Campylopus clavatus*, Brown.

1. Inner and outer perichætial leaves.
2. Lower branch leaf (fruiting).
3. Middle branch leaf (fruiting).
4. Middle stem leaf.
5. Upper stem leaf.
6. Capsule.

Fig. 4.—*Campylopus sparksii*, n.s.

1. Outer perichætial leaf.
2. Inner perichætial leaf.
3. Leaf outside perichætial.
4. Lower branch leaf (fruiting).
5. Middle stem leaf.
6. Upper stem leaf.
7. Capsule.
8. Calyptra.

Fig. 5.—*Campylopus torquatus*, Mitten.

1. Inner and outer perichætial leaves.
2. Lower branch leaf (fruiting).
3. Middle branch leaf (fruiting).
4. Upper branch leaf (fruiting).
5. Middle stem leaf.
6. Upper stem leaf.
7. Capsule.
8. Calyptra.

Plate XXXVI.

Fig. 6.—*Campylopus cockaynii*, n.s.

1. Perichætial leaves.
2. Middle branch leaf (fruiting).
3. Upper branch leaf (fruiting).
4. Middle stem leaf.
5. Upper stem leaf.
6. Capsule.
7. Peristome.

Fig. 7.—*Campylopus traillii*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf
3. Lower branch leaf (fruiting).
4. Upper branch leaf (fruiting).
5. Middle branch leaf (fruiting).
6. Middle stem leaf.
7. Upper stem leaf.
8. Capsule.

Fig. 8.—*Campylopus searellii*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaves.
3. Upper branch leaf (fruiting).
4. Lower branch leaf (fruiting).
5. Middle branch leaf (fruiting).
6. Middle stem leaf.
7. Upper stem leaf.
8. Capsule.
9. Peristome.

Fig. 9.—*Campylopus bellii*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper branch leaf (fruiting).
4. Middle branch leaf (fruiting).
5. Lower branch leaf (fruiting).
6. Middle stem leaf.
7. Upper stem leaf.
8. Capsule.
9. Calyptra.

Fig. 10.—*Campylopus walkerii*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper branch leaf (fruiting).
4. Middle branch leaf (fruiting).
5. Lower branch leaf (fruiting).
6. Middle stem leaf.
7. Upper stem leaf.
8. Capsule.
9. Peristome.
10. Calyptra.

PLATE XXXVII.

Fig. 11.—*Campylopus rarus*, n.s.

1. Perichætial leaf.
2. Upper branch leaf (fruiting).
3. Middle branch leaf (fruiting).
4. Outside perichætial leaf.
5. Middle stem leaf.
6. Upper stem leaf.
7. Middle stem leaf (from specimen found growing in water).
8. Capsule.

Fig. 12.—*Campylopus ohingaitii*, n.s.

1. Perichætial leaves.
2. Upper branch leaf (fruiting).
3. Middle branch leaf (fruiting).
4. Lower branch leaf (fruiting).
5. Middle stem leaf.
6. Upper stem leaf.
7. Capsule.
8. Peristome.
9. Calyptra.

Fig. 13.—*Campylopus bicolor*, Hornsch.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper branch leaf (fruiting).
4. Middle branch leaf (fruiting).
5. Lower branch leaf (fruiting).
6. Middle stem leaf.
7. Upper stem leaf.
8. Capsule.
9. Calyptra.

Fig. 15.—*Campylopus stewartii*, n.s.

1. Stem leaves (middle).
2. Stem leaves (upper), immature.

Fig. 16.—*Campylopus gulliverii*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Middle branch leaf.
4. Lower branch leaf.
5. Upper stem leaf.
6. Lower stem leaf.
7. Capsule.
8. Peristome.
9. Calyptra.

PLATE XXXVIII.

Fig. 17.—*Campylopus cylindricothecum*, n.s.

1. Perichætial leaves.
2. Upper branch leaf (fruiting).
3. Middle branch leaf (fruiting).
4. Lower branch leaf (fruiting).
5. Middle stem leaf.
6. Upper stem leaf.
7. Capsule.
8. Peristome.
9. Calyptra.

Fig. 18.—*Campylopus ellipticothecum*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Middle branch leaf (fruiting).
4. Lower branch leaf (fruiting).
5. Middle stem leaf.
6. Upper stem leaf.
7. Capsule.
8. Calyptra.

Fig. 19.—*Campylopus arcuatus*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper branch leaf (fruiting).
4. Middle branch leaf (fruiting)
5. Middle stem leaf.
6. Upper stem leaf.
7. Capsule.
8. Calyptra.

Fig. 20.—*Campylopus otaramaii*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Middle stem leaf.
4. Upper stem leaf.
5. Capsule.

Fig. 21.—*Campylopus arenarius*, n.s.

1. Perichætial leaves.
2. Middle branch leaf (fruiting).
3. Upper branch leaf (fruiting).
4. Lower branch leaf (fruiting).
5. Middle stem leaf.
6. Upper stem leaf.
7. Capsule.
8. Calyptra.

ART. XLIII.—*Further Notes on the New Zealand* Musci: *Genus* Trichostomum, *with Descriptions of some New Species.*

By ROBERT BROWN.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1896.*]

Plates XXXIX.-XLIII.

IN the genus *Trichostomum* many of the plants are very minute, growing in patches or small tufts, and are generally found at low elevations on damp rocks or clay banks. Plants found in the former habitat are never found in the latter, and *vice versa*. The fruiting period of this genus is generally from the beginning of September to the end of November. On the capsules reaching maturity dehiscence speedily takes place, and it is very difficult after that stage has been reached to find operculums or perfect peristomes, these having been dispersed by the strong winds which prevail about that season.

I have described and figured all the New Zealand species of this genus which have been collected by me during a large number of years. There will also be found some plants described and figured which lack some of their generic parts —viz., peristome or calyptra. Owing to this want their position in the genus is somewhat doubtful. I have provisionally placed them here, as the genus *Trichostomum* is the one to which they have apparently the closest affinity, owing to the similarity in form of the capsule, &c.

I have, as usual, experienced an immense amount of difficulty in attempting to identify some of the plants collected by me with those already described (and some of them figured) in Hooker's "Flora of New Zealand," Schimper's Mus. Eur. and Brio. Brit., owing to the brief and incomplete descriptions, and also little or incorrect figuring.

I have only been enabled, with satisfaction to myself, to identify three—viz., *T. laxifolium*, *T. elongatum*, and *T. setosum*—but perhaps I may be wrong even here. For the assistance of those who may be desirous of following up this interesting branch of botany, I have carefully figured these three plants, but not described them.

T. lingulatum is very correctly described and drawn in Hooker's "Flora of New Zealand," and I have had no difficulty in satisfactorily establishing its identity, so I have not figured this moss. It used to grow near the Christchurch Museum, but I have not come across it now for a number of years.

It is just possible I may have described and drawn plants

already treated of, but if I have done so my excuse will be found in the before-mentioned facts. In some instances I find that several different species would partly correspond with a written description of one plant, but owing to the above reasons I have been obliged to treat all as new species.

I have divided this genus into two sections—Section I., leaves slender; Section II., leaves not slender—and it will be at once seen on reference to the Plates how particularly appropriate this subdivision is.

I may again mention that my figures are all drawn with a power of 25 diameters; and, as the differences between each plant in almost every instance are microscopic, it is of the utmost importance that this scale should be adhered to.

Section I.

Leaves slender.

1.	Trichostomum	falcatum, *sp. nov.*
	"	" " *var. β.*
2.	"	calcareum, *sp. nov.*
3.	"	radiculosum, *sp. nov.*
4.	"	brevirostrum, *sp. nov.*
5.	"	avonensis, *sp. nov.*
6.	"	buchanani, *sp. nov.*
7.	"	filiformifolium, *sp. nov.*
	"	" " *var. β.*
8.	"	(?) hallii, *sp. nov.*
9.	"	moretonii, *sp. nov.*
10.	"	elongatum,† *Hook. f. and Wils.*
11.	"	setosum,* *Hook. f. and Wils.*
	"	" *var. β.**
12.	"	laxifolium,† *Hook. f. and Wils.*

Section II.

Leaves not slender.

1.	Trichostomum	lingulatum,† *Hook. f. and Wils.*
2.	"	minutifolium, *sp. nov.*
3.	"	apiculatum, *sp. nov.*
4.	"	searellii, *sp. nov.*
5.	"	ligulatum, *sp. nov.*
6.	"	rostratum, *sp. nov.*
7.	"	linearifolium, *sp. nov.*
8.	"	cockaynii, *sp. nov.*
9.	"	gracile, *sp. nov.*
10.	"	binnsii, *sp. nov.*
11.	"	repandifolium, *sp. nov.*
12.	"	contortifolium, *sp. nov.*
13.	"	curvithecum, *sp. nov.*

* Not described in this paper. † No figures or description.

Section I.

Leaves slender.

1. *T. falcatum*, sp. nov.

Plants diœcious, growing in small patches, yellowish-green, about ¼in. high. *Stems* unbranched. *Leaves* inserted all round the stem, imbricating, secund, falcate; upper leaves, base sheathing, obovate, tapering into a slender point, twice the length of the base; middle ones shortly oblong-lanceolate, tapering into a slender point, twice the length of their base; lower, very small, lanceolate, tapering into a slender point. *Nerve* running into the slender points. *Margins* entire. *Areola* oblong. *Leaves* unaltered when dry. *Perichætial leaves* cylindric, sheathing suddenly, tapering into a slender point, as long as the sheathing portion, nerved, apocarpous. *Fruitstalk* ½in. long, erect or inclined. *Capsule* variable in size, cylindric, slightly oblique. *Annulus* deciduous. *Peristome* single, filiform, and short, granulate. *Operculum* about one-fourth the size of the capsule, slightly oblique or straight. *Calyptra* cucullate.

Var. β. Capsule nearly one-half smaller.

Hab. Damp ground, South Fiord, Lake Te Anau; December, 1889. Collected by R. B.

2. *T. calcareum*, sp. nov.

Plants monœcious, growing in small dense patches, ¼in. high, green above, brown below. *Stems* simple or branched. *Leaves* inserted all round the stem, closely imbricating, erect or erecto-patent; upper ones shortly oblong-lanceolate, tapering into a slender point, one and a half times longer than the sheathing-base; middle ones subulate, tapering gradually from the base; lower ones smaller, similar in outline to the middle ones. *Nerve* disappearing in the point. *Margins* entire, erect when dry. *Lower areola* oblong. *Perichætial leaves* erect, cylindrical, sheathing, tapering into a slender point, about the length of the sheathing portion, nerved, apocarpous. *Seta* ⅜in. long. *Capsule* oblique, inclined, ovate-oblong, slightly narrowed to the mouth, annulate. *Peristome* single, long, filiform, granulate, united at the base into a short tube. *Operculum* one-fifth the length of the capsule, stout, conico-rostrate. *Calyptra* cucullate. *Antheridia* gemmiform, axillary.

Hab. On damp limestone rocks, Castle Hill, West Coast Road; March, 1891. Collected by R. B.

3. *T. radiculosum*, sp. nov.

Plants growing in dense patches, yellowish-green, ¼in.–¾in. high. *Stems* nearly simple, radiculose. *Leaves* inserted all round the stem, closely imbricating, secund; upper leaves,

base erect sheathing, ovate, tapering into a slender falcate hair-point, which is about twice the length of the base. *Margins* entire, nerved; middle ones similar to the upper; lower small, but similar in their outline. *Areola:* lower oblong. *Leaves* unaltered when dry. *Perichætial leaves* base convolute, sheathing, tapering into a slender curved hair-point, about twice the length of the sheathing portion, apocarpous. *Fruitstalk* slender, erect or inclined, $\frac{1}{16}$in. long. *Capsule* ovate, slightly oblique. Other parts not found.

Hab. Damp ground, near Lake Te Anau; January, 1890. Collected by R. B.

4. *T. brevirostrum*, sp. nov.

Plants growing in small loose patches, $\frac{1}{8}$in. high, yellowish-green. *Stems* simple. *Leaves* inserted all round the stem, imbricating, secund, small; upper ones sheathing at the base, oblong, tapering into a point, slightly longer than the base. *Margins* entire, nerved; middle, shorter, base ovate, tapering into a point, one and a half times longer than the base; lower, small, tapering from the base to the apex, unaltered when dry. *Lower areola* oblong. *Perichætial leaves* erect, cylindric, sheathing, suddenly contracted into a point, slightly longer than the sheathing portion, apocarpous. *Seta* $\frac{1}{2}$in. to 1in. long, red. *Capsule* cylindrical, slightly oblique, unequal, annulate. *Peristome* deciduous, short, single, granulate. *Operculum* short, conico-rostrate, oblique, a quarter to one-fifth the size of the capsule. *Calyptra* cucullate.

Hab. Damp ground, near Lake Te Anau; January, 1890. Collected by R. B.

5. *T. avonense*, sp. nov.

Plants monœcious, growing in small dense patches, $\frac{1}{4}$in.–$\frac{3}{8}$in. high, green. *Stems* simple or slightly branched. *Leaves* inserted all round the stem closely imbricating, erecto-patent, slightly incurved towards the apex; upper ones linear-lanceolate, acuminate, minutely apiculate, semi-convolute. *Margins* entire. *Nerve* continued to the apex; middle and lower ones smaller, but similar to the upper ones in outline, crisp when dry. *Areola:* upper, small, dense; lower, quadrate. *Perichætial leaves* smaller than the upper ones, nearly erect, convolute, sheathing, then tapering into an acuminate point, shorter than the sheath, apocarpous. *Seta* inclined, slender, $\frac{1}{4}$in. long. *Capsule* elliptic. *Peristome* single, granulate. *Operculum* nearly straight, conico-subulate. *Beak* slender, nearly two-thirds the length of the capsule. *Calyptra* cucullate.

Hab. Damp ground, plantations near the River Avon; October, 1881. Collected by R. B.

6. *T. buchanani*, sp. nov.

Plants growing in dense patches, ½in. high, yellowish-green above, brown below. *Stems* simple or branched. *Leaves* inserted all round the stem, erecto-patent or slightly secund; upper ones, lower half linear-lanceolate, upper tapering into a slender point minutely toothed at the apex, semi-convolute; middle smaller, but very similar in outline. *Nerve* continued to the apex, crisp when dry. *Areola* small, quadrate below, linear above. *Perichætial leaves* erect, cylindric, sheathing, tapered into an acuminate point, one-third the length of the sheathing portion, apocarpous. *Seta* erect or inclined, slender, ½in.–¾in. long. *Capsule* small, ovate-oblong, slightly narrowed to the mouth. Other parts not found.

Hab. Damp banks, old bed of River Waimakariri; September, 1883. Collected by R. B. (Named after Mr. John Buchanan, of Dunedin.)

7. *T. filiformifolium*, sp. nov.

Plants diœcious, growing in dense tufts, yellowish-green, ¾in. to 1in. high, very slender, and but slightly branched. *Leaves* inserted all round the stem, loosely imbricating; upper leaves, lower portion oblong, erect, sheathing, suddenly contracted into a slender hair-point, two to three times longer than the sheathing portion, minutely toothed at the apex, erecto-patent or spreading, nerved; middle ones similar to the upper; lower, small, erect, oblong, sheathing, suddenly contracted into a slender hair-point, two to two and a half times longer than the lower portion. *Areola* small, linear. *Leaves* erect, and spirally twisted at the apex when dry. *Perichætial leaves* slightly longer. *Base* cylindric, sheathing, suddenly tapered into a long slender hair-point, two and a half times longer than the base. *Fruit* terminal. *Fruitstalk* slender, 1in. long, erect. *Capsule* ovate-oblong, slightly narrowed towards the mouth. Other plants have been destroyed by insects after collection.

Hab. Damp banks, on River Teremakau; February, 1889. Collected by R. B.

Var. β: *Hab.* At the River Bealey. Collected by R. B.

8. *T. hallii*, sp. nov. (? *Tortula*).

Plants monœcious, growing in dense tufts, 2¼in. high, yellowish-green above, pale-green below. *Stems* branched, radiculose. *Leaves* inserted all round the stem, subsecund; upper ones with a short sheathing ovate or obovate base, tapering into a long slender point, four and a quarter times the length of the base; middle, shortly ovate, tapering

into a point four and a quarter times the length of the base. *Nerve* disappearing below the toothed apex, scarcely altered when dry. *Areola* linear, oblong. *Alar cells* quadrate. *Perichætial leaves* with a short convolute, sheathing-base, suddenly contracted into a long slender point, two and a half times the length of the sheath, apocarpous. *Fruit-stalk* slender, erect or inclined, 1⅝in. long, pale. *Capsule* ovate-oblong, narrowing to the mouth. Other parts not found.

Hab. On decaying wood, South Fiord, Lake Te Anau; January, 1890. Collected by R. B. (Named after W. Y. H. Hall, Esq., solicitor, Invercargill.)

9. *T. moretonii*, sp. nov. (? *Tortula*).

Plants monœcious, yellowish above, pale-brown below, 1½in. high. *Stem* subdichotomously branched, radiculose. *Leaves* inserted all round the stem, flexuous, imbricating; upper ones, base erect, adpressed, oblong or oblong-obovate, tapering into a subulate point, recurved or incurved; middle, broader at the base, shortly ovate-lanceolate, tapered into a subulate apex. *Nerve* disappearing at the apex. *Margins* entire, very crisp when dry. *Areola:* upper, small, quadrate; lower, oblong. *Perichætial leaves* long, erect, innermost longest, convolute, sheathing, suddenly contracted into a slender point, shorter than the convolute portion, apocarpous. *Fruitstalk* 2in. long, slender, pale. *Capsule* ovate-oblong, narrowing to the mouth. *Peristome* broken and imperfect. *Operculum* and *calyptra* not found.

Hab. Decaying wood, head of South Fiord, Lake Te Anau; January, 1890. Collected by R. B.

This plant is described from a small patch found growing in the middle of a tuft of *T. hallii* of this paper.

10. *T. elongatum*, Hook. f. and Wils.

Hab. Port Lyttelton Hills; damp banks. Collected by R. B.

11. *T. setosum*, Hook. f. and Wils.

Hab. Port Lyttelton Hills; damp banks. Collected by R. B.

Var. β. Capsules smaller and leaves longer. Collected by R. B.

12. *T. laxifolium*, Hook. f. and Wils.

Hab. Damp banks, Lake Te Anau; West Coast; Banks Peninsula; and in the North Island. Collected by R. B.

Section II.

Leaves not slender.

1. *T. lingulatum*, Hook. f. and Wils.

Hab. Christchurch Domain; 1888. Collected by R. B.

2. *T. minutifolium*, sp. nov.

Plants growing in small dense patches, ⅛in. high, dark-green. *Stems* simple or branched near the base. *Leaves* small, few, inserted all round the stem, imbricating, spreading; upper ones oblong, rounded to an acute apex, concave. *Margins* entire, slightly recurved or flat. *Nerve* stout, keeled, minutely excurrent; middle, oval, minutely apiculate; lower, ovate, acute, crisp when dry. *Areola* small, quadrate, larger towards the base. *Perichætial leaves* smaller, the innermost smallest, ovate, acute, nerved to the apex, apocarpous. *Fruit-stalk* ⅛in. long, inclined. *Capsule* small, elliptic, inclined. *Peristome* minute, single, granular, united into a short tube at the base. *Operculum* conico-rostrate, oblique, one-third shorter than the capsule. *Calyptra* cucullate.

Hab. Damp rocks, gorge of the River Hurunui; April, 1893. Collected by R. B.

3. *T. apiculatum*, sp. nov.

Plants monœcious, growing in patches, ⅛in.–$\frac{3}{16}$in. high, pale-green above, simple or branched near the base. *Leaves* inserted all round the stem, erect or erecto-patent, closely imbricating; upper ones oblong-lanceolate, apiculate, incurved at the apex. *Nerve* excurrent, concave. *Margins* entire, recurved; middle ones slightly longer and narrower than the upper ones, but otherwise similar; the lower are smaller, and crisp when dry. *Areola*: upper, opaque; lower, quadrate. *Perichætial leaves* ovate-oblong, apiculate, innermost smallest, apocarpous. *Seta* ¼in. long. *Capsule* ovate, narrowed to the mouth. *Peristome* single, small, granular, united by a short tube below. *Operculum* oblique, conico-rostrate, two-thirds shorter than the capsule. *Calyptra* cucullate.

Hab. Damp banks, Port Lyttelton Hills; September, 1882. Collected by R. B.

4. *T. searellii*, sp. nov.

Plants monœcious, growing in dense patches, ¼in. to ⅝in. high, green. *Stems* simple or branched from the base. *Leaves* inserted all round the stem, imbricating, erecto-patent, oblong, rounded to an acute point, or oblong, tapering into an acute point, concave at the apex. *Margins* entire, slightly recurved. *Nerve* keeled, slightly excurrent, crisp when dry. *Areola*: upper, small, dense; lower, quadrate. *Perichætial leaves* smaller than the upper ones, oblong, acute, rounded at the

base, apocarpous. *Seta* erect or inclined, ⅜in.–½in. long. *Capsule* ovate, narrowed towards the mouth. *Operculum* oblique, conico-rostrate, about half the length of the capsule. *Peristome* single, granular, united at the base. *Calyptra* cucullate.

Hab. Damp banks, Port Lyttelton Hills; October, 1890. Collected by R. B.

5. *T. ligulatum*, sp. nov. (? *Tortula*).

Plants monœcious, growing in small dense tufts, ⅛in.–¼in. high, olive-green. *Stems* simple or branched from the base. *Leaves* inserted all round the stem, erecto-patent, imbricating; upper ones oblong-lanceolate, acute, slightly incurved at the apex. *Margins* entire, flat. *Nerve* keeled, reddish-brown, ending at the apex; middle shorter than the upper ones, otherwise similar, crisp when dry. *Areola:* upper, dense; lower, oblong. *Perichætial leaves* shorter than the upper leaves, erecto-patent, oblong-lanceolate, acute, apocarpous. *Seta* inclined, ¼in. long, spirally twisted when dry. *Capsule* subelliptic. *Operculum* and *calyptra* not found.

Hab. Damp rocks, Mount Torlesse; March, 1891. Collected by R. B.

6. *T. rostratum*, sp. nov. (? *Tortula*).

Plants growing in small, dense, pulvinate tufts, ⅛in. high, dark-brown. *Stems* branched near the base. *Leaves* inserted all round the stem, densely imbricating, erecto-patent; upper ones ovate-lanceolate, acuminate; middle, ovate-lanceolate, acute. *Nerve* keeled, reddish, slightly excurrent. *Margins* entire, slightly concave, crisp when dry. *Areola:* upper, very small, dense; lower, oblong. *Perichætial leaves* erect, linear-lanceolate, acute, nearly as long as the upper ones. *Nerve* continuous, apocarpous. *Seta* ⅜in. long, erect. *Capsule* cylindric. *Operculum* slightly oblique, conico-subulate, about as long as the capsule. *Calyptra* not found.

Hab. Crevices of limestone rocks, Broken River, West Coast Road; March, 1891; fruiting very sparingly. Collected by R. B.

7. *T. linearifolium*, sp. nov.

Plants monœcious, growing in small dense patches, yellowish-green, ¼in. high. *Stems* branched near the base. *Leaves* inserted all round the stem, closely imbricating, erecto-patent, recurving towards the apex; upper ones linear, obtuse. *Margins* entire. *Nerve* keeled, ending immediately below the apex; middle similar to the upper ones, crisp when dry. *Areola:* upper, small; lower, oblong. *Perichætial leaves* smaller than the others, innermost smallest, linear, obtuse. *Nerve* ending below the apex, apocarpous. *Seta* erect, red,

twisted spirally when dry. *Capsule* ovate-oblong. *Peristome* single, immature. *Operculum* oblique, conico-rostrate, one-third shorter than the capsule. *Calyptra* not found.

Hab. Damp rocks, near Lake Te Anau; January, 1890. Collected by R. B.

8. *T. cockaynii*, sp. nov.

Plants growing in small dense patches, ¼in.–½in. high, dark-brown. *Stems* branched, branches very short. *Leaves* inserted all round the stem, densely imbricating, erecto-patent, slightly recurved, small; upper ones linear-lanceolate, acuminate; middle, shorter lanceolate, acuminate, concave. *Nerve* linear, continued to the apex, reddish, keeled. *Margins* entire, crisp when dry. *Areola:* upper, small, dense; lower, oblong. *Perichætial leaves* smaller than the upper leaves, linear-lanceolate, acute, nerved to the apex, apocarpous. *Seta* slender, ¼in. long. *Capsule* cylindric, gibbous. *Peristome* single, teeth free to the base, granulate. *Operculum* and *calyptra* not found.

Hab. Crevices of rocks, Broken River, West Coast Road; March, 1891 Collected by R. B.

9. *T. gracile*, sp. nov.

Plants diœcious, growing in dense patches, ¼in. high, green. *Stems* branched, branches short. *Leaves* inserted all round the stem, imbricating, spreading or erecto-patent, all very similar in outline, but increasing in size towards the apex of the stem, linear-lanceolate, acuminate, concave. *Nerve* keeled, disappearing at the apex. *Margins* entire, crisp when dry. *Areola* dense above, quadrate below. *Perichætial leaves* narrower, linear-lanceolate, acuminate, erect, apocarpous. *Seta* ¼in.–⅜in. long, erect, reddish, slightly flexuous. *Capsule* elliptic. *Peristome* single, united at the base by a short tube, granulate. *Operculum* oblique, subulate, about two-thirds the length of the capsule. *Calyptra* cucullate.

Hab. Damp rocks, Port Lyttelton Hills; July, 1882. Collected by R. B.

10. *T. binnsii*, sp. nov.

Plants growing in small dense patches, ¼in.–⅜in. high, pale-green. *Stems* simple or slightly branched. *Leaves* inserted all round the stem, closely imbricating, erecto-patent, ovate-lanceolate, acute, slightly flexuous; upper ones longest. *Margins* entire, concave. *Nerve* keeled, excurrent as a minute apiculus, crisp when dry. *Areola:* upper, dense; lower, oblong near the base. *Perichætial leaves* flexuous, ovate-lanceolate, acute. *Nerve* continued to the apex, apocarpous. *Seta* ⅜in. long, red. *Capsule* slightly inclined, elliptic, oblique. *Peristome* single, united close to the base, granulate.

Operculum oblique, conico-subulate, nearly half the length of the capsule. *Calyptra* cucullate.

Hab. Damp rocks, Port Lyttelton Hills; September, 1888. Collected by R. B. Named in honour of Mr. W. Binns.

11. *T. repandifolium*, sp. nov.

Plants monœcious, growing in very dense patches, ¼in.–½in. high, green. *Stems* simple or branched. *Branches* short, fastigiate. *Leaves* inserted all round the stem, closely imbricating, erecto-patent, linear-lanceolate, acuminate, flexuous, recurving near the apex. *Margins* entire, slightly crisp, concave. *Nerve* slightly excurrent. *Leaves* all very similar in outline; lower ones smallest, crisp when dry. *Areola:* upper, dense; lower, oblong. *Perichætial* flexuous, narrow, linear-lanceolate, nerved, apocarpous. *Seta* slender, erect, ¼in. long. *Capsule* inclined, cylindric, recurved. *Peristome* single, slender, granulate, united near the base by a very short tube. *Operculum* narrow, subulate, longer than half the length of the capsule. *Calyptra* cucullate.

Hab. Damp rocks, Weka Pass; November, 1886. Collected by R. B.

12. *T. contortifolium*, sp. nov.

Plants monœcious, growing in patches, ⅛in.–$\frac{3}{16}$in. high, pale-green. *Stems* branching at the base. *Leaves* inserted all round the stem, imbricating, erecto-patent, upper and middle ones oblong-lanceolate, acuminate, flexuous, concave. *Margins* entire. *Nerve* keeled, pellucid, disappearing at the apex, crisp when dry. *Areola:* upper, dense; lower, oblong. *Perichætial leaves* smaller, narrow, linear-lanceolate, erect or recurved, nerved. *Margins* entire, apocarpous. *Seta* erect, $\frac{3}{16}$in. long *Capsule* cylindric, oblique *Annulus* persistent. *Peristome* slender, single, granulate. *Operculum* conico-subulate, one-third the length of the capsule. *Calyptra* cucullate.

Hab. On banks, West Coast Road. Collected by R. B.

13. *T. curvithecum*, sp. nov.

Plants growing in small patches, ¾in. high, yellowish-green above, reddish-brown below. *Stems* dichotomously branched. *Leaves* inserted all round the stem, closely imbricating, erecto-patent or slightly spreading, incurved, upper and middle ones ovate-lanceolate, subacute, minutely toothed at the apex. *Nerve* continued to the apex, reddish, crisp when dry. *Areola*: upper, dense; lower, oblong. *Perichætial leaves* erect, oblong-lanceolate, subulate, sheathing at the base, nerved to the apex, apocarpous. *Seta* inclined, reddish, ¼in. long. *Capsule* cylindric, curved, annulate. *Peristome* single, granulate, free to the base. *Operculum* narrow,

conico-subulate, short, one-seventh the length of the capsule, curved upwards. *Calyptra* cucullate.

Hab. Damp rocks, Broken River; March, 1891. Collected by R. B.

EXPLANATION OF PLATES XXXIX.-XLIII.

Plate XXXIX.

Fig. 1.—*Trichostomum falcatum*, n.s.

1. Perichætial leaves.
2. Upper stem leaf.
3. Middle stem leaf.
4. Capsule.
5. Peristome.

Fig. 1A.—*Trichostomum falcatum*, n.s., var. *β*.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaf.
5. Lower stem leaf.
6. Capsule.

Fig. 2.—*Trichostomum calcareum*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaf.
5. Capsule
6. Operculum.
7. Peristome.

Fig. 3.—*Trichostomum radiculosum*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaf.
5. Capsule.

Fig. 4.—*Trichostomum brevirostrum*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaf.
5. Lower stem leaf.
6. Capsule
7. Peristome.

Fig. 5.—*Trichostomum avonense*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaves
5. Capsule.

Fig. 6.—*Trichostomum buchanani*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaves.
4. Middle stem leaf.
5. Capsule.

Fig. 7.—*Trichostomum filiformifolium*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.

4, 5. Lower stem leaves.

6. Capsule.

Plate XL.

Fig. 7A.—*Trichostomum filiformifolium*, n.s., var. *β*.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaves.
5. Capsule.

Fig. 8.—*Trichostomum hallii*, n.s.

1. Perichætial leaves.
2. Upper stem leaves.
3. Capsule.

Fig. 9.—*Trichostomum morstonii*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaves.
4. Middle stem leaf.
5. Capsule.

Fig. 10.—*Trichostomum elongatum*, H.f. and W.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Capsule.

PLATE XLI.

Fig. 11.—*Trichostomum setosum*, H.f. and W.

1. Perichætial leaves.
2. Upper stem leaves.
3. Middle stem leaf.
4. Lower stem leaf.
5. Capsule.

Fig. 11A.—*Trichostomum setosum*, var. *β*.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaves.
5. Capsule.

Fig. 12.—*Trichostomum laxifolium*, H.f. and W.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaves.
4. Middle stem leaf.
5. Capsule.

Fig. 2.—*Trichostomum minutifolium*, n.s.

1. Perichætial leaves.
2. Leaf outside perichætial.
3. Upper stem leaf.
4. Lower stem leaves.
5. Capsule.
6. Peristome.

Fig. 3.—*Trichostomum apiculatum*, n.s.

1. Perichætial leaves.
2. Leaf outside perichætial.
3, 4. Upper stem leaves.
5. Lower stem leaf.
6. Capsule.
7. Peristome.

PLATE XLII.

Fig. 4.—*Trichostomum searellii*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaves.
5. Capsule.

Fig. 5.—*Trichostomum ligulatum*, n.s.

1. Perichætial leaves.
2. Upper stem leaf.
3. Middle stem leaf.
4. Capsule.

Fig. 6.—*Trichostomum rostratum*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaves.
5. Capsule.

Fig. 7.—*Trichostomum linearifolium*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaves.
5. Capsule.

Fig. 8.—*Trichostomum cockaynii*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaves.
5. Capsule, with peristome.

PLATE XLIII.

Fig. 9.—*Trichostomum gracile*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaf.
5. Lower stem leaf.
6. Capsule.

Fig. 10.—*Trichostomum binnsii*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaves.
5. Capsule.

Fig. 11.—*Trichostomum repandifolium*, n.s.

1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaves.
5. Capsule.
6. Operculum.

Fig. 12.—*Trichostomum contortifolium*, n.s.
1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaves.
4. Middle stem leaf.
5. Capsule and operculum.

Fig. 13.—*Trichostomum curvithecum*, n.s.
1. Perichætial leaves.
2. Outside perichætial leaf.
3. Upper stem leaf.
4. Middle stem leaf.
5. Capsule.
6. Peristome.

Art. XLIV.—*On the Disappearance of the New Zealand Bush.*

By the Rev. P. Walsh.

[*Read before the Auckland Institute, 19th July, 1896.*]

No one who has lived any length of time in New Zealand can have failed to observe the rapid disappearance of the natural bush, and even the casual visitor discerns the evidence of it in the appearance of the country, though he may not be able to appreciate the rate at which it is going on. Wherever we go—along the coast or inland, on plain or mountain—we find in the gaunt skeletons which disfigure the open, and in the brown and withered margin of the standing forest, unmistakable signs of destruction and decay. It is the purpose of the present paper to point out some of the principal causes which have combined to produce this state of things, my information on the subject being based on observations made during a residence of thirty years in various parts of the colony.

There can be little doubt that at some distant period the greater part, if not the whole, of New Zealand was covered with forest. The evidence of this is found not only in the roots embedded *in situ* in the open ground and in the remains of forest buried beneath the soil, but also in the surface corrugations caused by the falling-over of trees of which no organic traces at present remain.

Of the causes of the disappearance some have been in operation during the long ages which preceded any human occupation of the country. In the regions of volcanic action there is no doubt that extensive areas of bush were destroyed at various periods by the lava-flows and by the hot stones ejected from the numerous craters, while still larger portions were buried under showers of ash and pumice and volcanic mud. In the northern gumfields, which cover a wide extent of country, whose present vegetation is mostly confined to a

scanty growth of tea-tree, the digging operations frequently reveal successive surfaces strewed with the remains of the primeval forest, while in other parts the same thing is often brought to light by mining and engineering works, as well as by landslips and river erosions. Wherever, in fact, excavation is conducted in alluvial or volcanic country it is usual to find the remains of a former vegetation, generally of large growth and frequently in sound condition.

It is probable that, had no other causes intervened beyond those already named, the country might have gradually become reafforested. So much, indeed, is indicated by the successive beds of timber that have been found—sometimes as many as two or three—one above the other. The destruction, though severe and often widespread, occurred at intervals; and there would generally be ample time for nature to reassert herself. But with the advent of a population, even though comparatively small and widely scattered, other conditions were introduced which made the work of destruction much more rapid and complete. The Maoris were a busy people, and, if not employed about the precincts of the *kainga*, they were generally roving the country on their hunting and fishing expeditions, visiting from settlement to settlement, or engaged in warlike expeditions. The fire-stick formed an important part of their travelling outfit, and was constantly in requisition to clear away the dense growth of fern or tea-tree which impeded their movements. The fires so kindled would sweep over the country during the dry summer months, scorching the edge of the bush, and gradually extending the area of open land. Such fires were noticed by Tasman as he sailed along the western coast two hundred and fifty years ago, and they are still to be seen in all parts of the country.

Much of the destruction of the bush is therefore to be accounted for both by natural causes and by several centuries of Maori occupation. But with the progress of European settlement a host of new conditions have been added, which, in conjunction with those already existing, have greatly precipitated matters. The Maori settlements were confined to certain localities where the conditions of soil, climate, &c., were peculiarly favourable, and, though comparatively numerous, they formed in the aggregate but a small fraction of the total area of the country. For want of proper tools, moreover, their bush-clearings were necessarily confined to the margin of the forest, where advantage would be taken of the dead timber, and were, in fact, little more than a "clean-up" after the former fires. But since the axe and saw have come into operation the living bush has been attacked throughout the length and breadth of the land, and not only is an increasing area annually deforested for farming purposes, but the bush is

gutted in all directions by timber-workings and road- and telegraph lines. Over these the fires find their way in successive dry seasons, ever penetrating more deeply into the standing forest, until sooner or later in many places the whole countryside is swept, and only a few isolated patches in some of the damper situations remain amid the general desolation.

It used to be said that the New Zealand bush, unlike that of Australia, would not burn standing. This was true to a certain extent, but the comparison no longer holds good under the present altered conditions, and the chief difference now is that while the Australian bush recovers more or less from the burn that of New Zealand perishes, never to be restored.

In its virgin state the New Zealand bush, with the exception perhaps of the kauri forest, was comparatively impervious to fire. The general bush was dense and dark. The tops of the trees formed a close canopy overhead, and the ground was covered with a succulent growth of ferns, mosses, and seedling plants, which protected the roots, and maintained everything in a moist condition; so that, with the exception of a small portion along the margin, killed by former fires and exposed to the action of the sun and wind, the whole bush was practically safe. But all this is now changed. As the cattle find their way in, the thick undergrowth is eaten or trodden down never to reappear. The network of superficial roots is barked and torn, and the soil, poached by the constant trampling of hoofs, is hardened in summer to the consistency of concrete. The consequence is that the larger trees, deprived of their natural protection, and unable to obtain a proper supply of sap, soon grow thin and open at the top, and many of the more delicate species die out altogether. The sun and wind find entrance, and the fronds of the nikau and the fern-tree, which flourished in the crypt-like shade, shorten and shrivel up. The ground is covered with fallen leaves. The old rotten logs, which represent the natural decay of centuries, are dried to powder, and before many years are past the whole bush, which originally retained its moisture like a sponge through the driest season, is ready to burn to extermination.

It is not to be supposed that the influence of the cattle is confined to the vicinity of the settlements, though it is felt here in a greatly intensified degree. At the present time there is practically no part of the bush—in the North Island at least—that is not overrun, more or less, and upon which they have not already left their mark, the tame stock browsing around the farms and townships, and wild mobs running at large among the back ranges and gullies. For years past this has been the case in the extensive mountainous districts extending along the West Coast from Whangape to the Manukau Heads,

and covered by an almost unbroken forest for a distance of a hundred and fifty miles. Here, far removed from any homestead, and in places as yet uninvaded by the bushman or the road-surveyor, the presence of the animals is already plainly indicated by the shrinking tops of the rata and the towai, and in the gradual extinction of the tawa and others of the more delicate forms of vegetation. The same thing is going on more or less all over the country, though, of course, it is not so conspicuous in the more newly-settled districts, and it is hard to say whether any portion of the forest between the North Cape and Stewart Island will be permanently secure.

The change which has gradually come over the bush in all the older settlements is often noticed by those who have an opportunity of making the comparison. In the early days, before the cattle had time to make much impression, a great deal more care than is at present required was taken in order to secure a good burn, and the fire, no matter how fierce, did not generally extend far beyond the margin of the clearing. Nowadays any kind of work is considered sufficient. Instead of the laborious lopping and under-scrubbing, formerly considered indispensable, "crush-and-smother" is the order of the day, and the chief difficulty is to keep the fire from travelling beyond all control.

The effect of the combination of destructive elements may be seen on a wide scale in any of the larger bush-settlements. On the Akaroa Peninsula, for instance, the forest has almost entirely disappeared within a comparatively few years, while the Forty-mile Bush, in Taranaki, and the Seventy-mile Bush, on the East Coast, will shortly exist only in name and in the recollection of the early settlers.

As may be inferred from the foregoing, all bush which has been invaded by cattle is liable to be swept by fires, and is sooner or later exterminated. The rate of destruction varies, however, a good deal with the conditions of situation, soil, and character of vegetation. Generally speaking, it is most quickly accomplished on high, airy situations, where the growth is usually more light and open, and especially on stiff clay lands, where it often takes place with surprising rapidity. All these conditions are united in the case of the kauri forest, which, in addition, possesses peculiar elements, rendering it liable to rapid extinction. As this class of bush is at once the most beautiful and economically valuable, a detailed account of its destruction will not be out of place.

The bushmen say that the kauri attracts the fire, and the statement is hardly an exaggeration. Wherever the kauri-trees grow, which they generally do in clumps scattered through the mixed bush, the ground is covered with a thick

layer of humus (*pukahu*), composed of vegetable fibre intermingled with fallen leaves, particles of gum, and scales from the resinous bark, the latter helping to form a solid bank, sometimes several feet in height, round the base of the trees. This, from the nature of its composition, is of a most inflammable character, and once ignited will burn for weeks together, smouldering underneath even when wetted on the surface, and "piping up" with every drying breeze. Every tree, of whatever sort, reached by the fire is killed. The tufts of the toe-kiwi—the "cutting-grass" of the bushmen—which are a feature of the kauri bush, are set in a blaze; and, as the flames flare up the loose bark of the ratas and the trunks of the more gummy specimens of the kauri, the masses of puwharawhara (Asteliads) which encumber the branches are ignited, and fall in fiery showers to form fresh centres of combustion. The open character of the kauri bush, moreover, and the comparative absence of the succulent growth before mentioned as a general characteristic of the New Zealand forest, both tend to facilitate the progress of the fire, which, when once properly started, will continue to burn until thoroughly drenched by the heavy autumnal rains, the most laborious efforts at extinction generally proving unavailing.

No description, however verbally accurate, will convey an idea of the scene of desolation presented by a kauri bush after the fire has gone through it. The ground is covered with a deep bed of ashes strewn with fallen branches and with the wreck of the smaller trees. Here and there a giant rata, its buttressed roots burnt through, has crashed down through everything, and lies with broken limbs and a smoky cavern in its hollowing trunk. The stately totaras, whose fibrous bark conducted the flames to the tops, when for a moment they became as so many blazing torches, now stand grim and black. The waving tufts of the toe-kiwi are represented by a coil of snake-like roots. The fern-tree's feathery fronds and the glossy curving spikes of the neinei hang shrivelled and limp, while the netted ropes of the mangemange are gone altogether—vanished in a puff of flame. All the ferns and mosses, the orchids and climbing plants, all the light and graceful undergrowth indigenous to the kauri bush, which made the place a fairy paradise, are charred and dead. The kauris alone seem to have escaped the general fate. With the exception of the more gummy specimens, and those which were exposed to the hottest part of the fire, they still stand proudly erect, the bark retaining its peculiar silvery sheen, and the head its noble crown of leaves. But this hopeful appearance is only deceptive. The slightest scorching about the root is sufficient to kill a kauri-tree, and though the leaves may remain green for months, as they frequently

do, once it has felt the heat of the fire its life is a thing of the past.

The first fire in a kauri bush may go on for months, and unless a strong wind is blowing, in exceptionally dry weather, its progress is generally slow, and often is scarcely perceptible. But when the second fire passes over it the destruction, only begun before, is quickly completed. By two or three years' time the ground is covered with fallen leaves and twigs and fragments of gum, together with the wreck of the bark, split up and flaked off in thick broad sheets. The sapwood, pierced by the worm and rotted by the action of the weather, is in a condition of tinder. A rank growth of ferns, rushes, and coarse grasses, nourished by the ash, has quickly taken possesion of the soil, and helps to carry the fire along. The fire once kindled spreads with frightful rapidity. A roaring torrent sweeps through the bush; every tree becomes a blazing torch, and the whole ground is covered with a sheet of billowy flame; and in an incredibly short time all that is left are a few smoking trunks and fallen logs. But the fire has not yet quite done with the kauri bush. By degrees the fern gives place to the tea-tree, and, as this is burnt by successive fires, before many years are past scarcely a charred stump remains to mark the site of one of the grandest triumphs of nature in the vegetable kingdom.

PREVENTION AND RESTORATION.

The question may naturally be asked, Are there no means of prevention and restoration?

In regard to prevention the answer has already been anticipated. All that is necessary is to hermetically seal the bush against the incursion of stock and make adequate provision against fires. But the remedy, though simple enough, is not always easy of application. It is obvious that no such general measure could be adopted in the case of the bush at large, especially in the neighbourhood of settlement, where all unoccupied land is used as a common run. However much we may lament it, the great bulk of the bush will have to take its chance; and, in regard to detached portions of small area, such as a man might hope to preserve on his farm, there are several difficulties to contend with which generally render an attempt in this direction fruitless. Not only are they in continual danger from accidental fires, but from want of the shelter of the surrounding bush, of which they originally formed a portion, they die back at the edges, and sooner or later resolve themselves into clumps of scrubby survivals of some of the more hardy varieties. It is possible that, by planting some quick-growing trees, such as the Australian wattles, round the portions intended to be preserved, both a

check to the advance of the fire and the required shelter would be provided. At any rate, the experiment is well worth trying. In the case of reserves chosen with due regard to topographical and climatic conditions the case is more hopeful. On some of our mountainous promontories and wooded islands there should be no difficulty, at a slight expense for fencing and supervision, in preserving for posterity large areas of forest of unsurpassed scenic beauty and of great economic value.

Restoration might also be hopefully attempted under similar conditions. Experiments in our parks and gardens show that most, if not all, of the native trees will grow freely under cultivation. But such an artificial procedure need not generally be taken Nature makes a brave effort to reclothe the hills and gullies of New Zealand in her verdant mantle, and if let alone would bring her work to completion. Under favourable circumstances seedling trees soon make their appearance, and if protected from injury would in due time attain to maturity. Of course, anything like a real restoration of the original bush is out of the question, but the "second growth" has a beauty of its own which is by no means to be despised. This natural attempt at reafforesting may be seen on a large scale in many parts of the colony, especially in elevated and damp situations, such as the steep hills and gullies of the Northern Peninsula, the ranges about Coromandel and Mercury Bay, and the upland portions of the Nelson Province; and it is interesting to notice that everywhere the trees which are characteristic of the locality are not long in making their appearance.

Nothing, however, either in the way of prevention or restoration can be hoped for without a radical change in public opinion, and a general improvement in public taste. So long as the farmer persists in cutting down the native growth that is at once an ornament to his property and a shelter to his stock, in order to make room for a row of *Cupressus macrocarpa* or *Pinus insignis*, or so long as the gum-digger and bush-larrikin are allowed to put a match into anything that will burn, there is not much hope for either prevention or restoration. Year by year the destruction will continue, and the rate of the disappearance of the New Zealand bush will be proportionately accelerated as population increases and settlement spreads abroad.

ART. XLV.—*Description of a New Genus of* Gramineæ.

By T. KIRK, F.L.S.

[*Read before the Wellington Philosophical Society, 17th February, 1897.*]

Plate XLIV.

AGROSTIDEÆ.

Simplicia, n.g.

SPIKELET solitary, 1-flowered, pedicellate, the rhachis produced into a minute bristle. Glumes, 3, the 2 outer unequal, minute, hyaline, persistent. Flowering-glume much longer than the outer glume, lanceolate-acuminate, awnless; nerves 2, rarely 3, obscure. Palea almost as long as the glume. Stamens 2 or 1. Stigmas 2. Lodicules 2. Ovary minutely stipitate; grain enclosed in the palea, free.

1. *S. laxa*, n.s.

Culms weak, decumbent, flaccid, filiform 10in.–18in. long. Leaves flat, 1in.–4in. long, $\frac{1}{10}$in.–$\frac{1}{8}$in. broad, sheath rather long, glabrous or pubescent; ligule short, lacerate. Panicle strict, narrow, with few short capillary branches. Spikelets about $\frac{1}{18}$in. long; outer glumes one-fifth to one-fourth as long as the flowering-glume, ovate, acute, minutely ciliate. Flowering-glume and palea pubescent or almost silky, the nerves of the former usually obscure. Palea as long as the flowering-glume, narrow, acute or subacute. Filaments short.

Hab. North Island—Dry River Station, Ruamahanga, Lower Wairarapa: January, 1880: *T. K.* South Island—Waikouaiti and Deep Stream, Otago: *D. Petrie!*

Some specimens may be polygamous, as suggested by Dr. Stapf, but I have not been able to determine this point, the material at my disposal being very limited; in some specimens the rhachilla is not easily made out. The Ruamahanga specimens are much weaker, and have narrower leaves than those from Otago, but there is no other difference. Both forms are protandrous.

I am greatly indebted to Dr. Stapf, who, at the request of Sir Joseph Hooker, has kindly examined this curious plant for me. He remarks, "It comes pretty near certain species of *Muhlenbergia*, but has a distinct though minutely-produced rhachilla, and is probably polygamous."

Local botanists will easily distinguish it from *Deyeuxia* by the outer glumes being only one-fifth the length of the awnless flowering-glume, which is destitute of hairs at the base.

EXPLANATION OF PLATE XLIV.

Simplicia laxa, T. Kirk. Natural size. 1. Unexpanded spikelet, enlarged.

Art. XLVI.—*Remarks on* Paratrophis heterophylla, *Bl.*

By T. Kirk, F.L.S.

[*Read before the Wellington Philosophical Society, 17th February, 1897.*]

Plates XLV. and XLVI.

Most New Zealand botanists have doubtless felt considerable uncertainty as to the specific identity of certain plants included, rightly or wrongly, under *Epicarpurus microphyllus*, Raoul, the "turepo" of the Maoris and the "milk-tree" of the settlers. Certainly any ordinary observer examining Raoul's beautiful drawing, and comparing it with the fine plate of *Trophis opaca* in the Banksian collection, would unhesitatingly conclude that two entirely different plants were represented by the artists, and for some time past I have been of the same opinion; but the examination of a large number of specimens from various localities has compelled me to believe that we have only a single species which exhibits an exceptional range of variation, so that it is desirable to point out the characteristics of the extreme forms.

Paratrophis heterophylla, Bl., Mus. Bot. Lugd. Bat., ii., 81.

In the young state the typical form has slender, flexuous, often tortuous twigs with brown bark, pubescent or even setose at the tips, and very brittle; the leaves are distant, membranous, green, ½in.–¾in. long, shortly petioled, varying from obovate to obovate-orbicular, cuneate at base, entire or deeply-lobed below, or even pinnatifid, acute, sharply toothed; stipules ovate-subulate, caducous. In this state the plant forms a bush or shrub 3ft.–8ft. high, which bears but a slight resemblance to the mature condition and rarely produces flowers.

Gradually the leaves become coriaceous, the bark changes to a grey colour, sometimes almost white, the leaves become obtuse, or even retuse, their margins crenate or crenate-dentate, while the lobation is less prominent and often disappears. The obovate outline may be retained or pass gradually into obovate-elliptic or elliptic-ovate; the length may vary from ¼in. or less to 1½in. In this state the plant may range from a shrub or bush to a small tree 40ft. high or more, with a trunk not exceeding 24in. in diameter, and pale-grey or whitish bark. Flowers are produced freely, the male catkins forming axillary or rarely terminal amenta ¾in.–1in. long, the flowers mixed with curious peltate scales,

having scarious white margins. Perianth deeply 4-partite, lobes rounded, ciliate; stamens 4, exserted. Female flowers in short 3–6-flowered spikes; flowers distant; perianth deeply 4-partite, the outer segments smaller than the inner; stigma short, bifid; ovary 1-celled, 1-ovuled. Fruit as large as a peppercorn, 1-seeded, red, spherical, tipped with the short straight style. The slender rhachis becomes pendulous as the fruit ripens; it is remarkable that the fruits are almost invariably solitary, although the spikes are 3–6-flowered.

Var. *elliptica* is erect from a very early stage, and does not appear to pass through the remarkable stages of leaf-variation described above. It may be, however, that more extended observation might render it necessary to modify this statement, but I have seen no indication of such change. The twigs are straight, erect, with brown bark. The leaves are erect and rather close set from the first, oblong or elliptic-oblong, acute, subacute, or obtuse, margins crenate or crenate-dentate, coriaceous, 1in.–3½in. long, ⅜in.–1in. broad, slightly narrowed at both ends, but not obovate. Both male amenta and female spikes are often geminate, although usually solitary, and are larger than those of the type, sometimes 1½in. long or more. The drupes, however, are numerous, the size of small peas, and, being produced in great profusion, resemble at a short distance racemes of red currants, the resemblance being increased by the slender rhachis being invariably pendulous. It seems not unlikely that the greater number of perfect fruits on a spike in this variety may be due to the spikes being usually developed on the naked portions of the branchlets, and thus being more readily fertilised than when hidden amongst the leaves, and it is not impossible that the more robust habit of this plant may be indirectly connected with the same characteristic. Notwithstanding the very different aspect presented by the extreme forms, a gentle gradation may be traced from the small membranous lobulate or pinnatifid leaves of the early stage of the type to the large elliptical entire leaves of var. *elliptica*, but it is not easy to find intermediate stages among the drupes.

Female flowers appear continuously through the season, especially in var. *elliptica*, in which they are developed to the end of February. In this form the unfertilised stigmas often remain on the rhachis until the drupes are nearly ripe. The wood is white, compact, and rather hard, but perishable.

Trophis opaca, Banks and Sol., *ex* Hook. f. Fl. N.Z., i. 224. *Epicarpurus microphyllus*, Raoul, Ann. Sc. Nat., ser. iii., ii. (1844), 117; Choix de Pl. de la Nouv.-Zél., xiv., t. 9; Hook. f., Handbk. N.Z. Fl., 251. *Taxotrophis microphylla*, F. Muell., Fragm. Phyt. Austr., vi., 193.

Hab. North and South Islands: Mangonui to Foveaux Strait. Great Barrier Island.

Var. *elliptica* = *Trophis opaca*, Banks and Sol., MSS. et Ic.

Hab. North Island: Mangonui to Cook Strait. Taranga Islands. Stephen Island. Chiefly in places near the sea.

The Banksian plate exhibits the male and female spikes mostly arranged in threes, springing from a terminal peduncle. I have not seen a specimen exhibiting this peculiarity.

It should have been mentioned that the male and female inflorescence is frequently metamorphosed into small but much-branched panicles, the branchlets of which are densely clothed with minute imbricating scales, without any trace of the organs of fertilisation. This diseased condition is most common in the small-leaved forms.

I have to express my indebtedness to the Bishop of Waiapu, to Frank V. J. Williams, Esq., of Waipara, to A. Williams, Esq., of Tuparoa, and other friends, for a copious supply of specimens from various localities; also to the authorities of the British Museum for a precious fragment of the original specimen in the Banksian collection.

The absence of any form of this plant from the Chatham Islands and Stewart Island is remarkable.

EXPLANATION OF PLATES XLV. AND XLVI.

Plate XLV.

Paratrophis heterophylla, Bl.

1. Leaves of young state.
2. Male flowers.
3. Female flowers.
4. Fruits.

All natural size.

Plate XLVI.

P. heterophylla, var. *elliptica*.

1. Male flowers.
2. Fruits.

All natural size.

ART. XLVII.—*On* Carmichaelia, Corallospartium, Huttonella, *and* Notospartium.

By T. KIRK, F.L.S.

[*Read before the Wellington Philosophical Society, 17th February, 1897.*]

CARMICHAELIA is perhaps the most characteristic of the many remarkable endemic genera of New Zealand phanerogamic plants, as, although absent from the larger outlying islands, Stewart Island, and the Chathams, it is represented from the North Cape to Foveaux Strait by numerous species, differing widely in habit and general appearance, but in all localities recognised by the settler as native broom and by the Maori as *makaka*.

Although one of the very earliest New Zealand genera collected by Europeans, our acquaintance with its numerous species has been of slow growth. In 1769 Banks and Solander collected the first species at Poverty Bay, and gave it the MS. name of *Genista compressa*. The next species was discovered by Forster in Dusky Sound, in 1772, and described in G. Forster's "Prodromus" as *Lotus arboreus*. The genus *Carmichaelia* was established by Robert Brown in 1825, but no additions were made until 1853, when four new species, discovered by Colenso, were described in Hooker's "Flora Novæ-Zelandiæ," Forster's plant being considered identical with the Banksian *Genista compressa*. In the "Handbook of the New Zealand Flora," published in 1864, the number of species is increased to nine, two of which were discovered by Colenso, but treated as varieties in the original Flora, the other two being remarkable southern plants. In 1871 the lamented Baron Von Mueller described *C. exsul*, of Lord Howe's Island, the tallest member of the genus, and the only species found outside New Zealand, and in 1878 *C. williamsii* was added to the flora. Numerous species have been described since that date; the number enumerated in the "Students' Flora of New Zealand," now in the Press, is twenty-five, arranged under the genera *Carmichaelia*, *Corallospartium*, and *Huttonella*. Two species of *Notospartium* must also be enumerated.

The species of *Carmichaelia* are admittedly difficult of definition. The learned author of the "Flora Novæ-Zelandiæ" wrote: "The species are extremely difficult to distinguish, and require much further elucidation on the spot; the characters employed appear far too variable" (i., 50); and in the

supplement to that work he adds, "I have received many forms of *Carmichaelia*, and they certainly do not tend to clear up the difficulty of discriminating the species, but rather complicate them, several of these being intermediate between those already defined. The whole genus requires careful revision in New Zealand, and a judicious selection of ticketed specimens from the same and different individuals at many different localities, various periods of growth, different seasons of the year, &c. Their habits and variations should also be narrowly watched in a growing state" (ii., 327). Speaking for myself, I am convinced that until this has been done it will be impossible to define the species in a thoroughly satisfactory manner, on account of the great amount of variability exhibited by many of them at different stages of growth. It is therefore obvious that I do not claim immunity from error in the descriptive portion of the following arrangement.

Carmichaelia, R. Br. In Bot. Reg., xi., 912 (1825).

With considerable variety in stature, habit, foliage, and inflorescence, all the species of this genus exhibit a 2-valved pod, with the margins and placentas consolidated and thickened, the valves falling away from this framework, or more rarely opening at the base or apex, leaving the solitary or numerous seeds attached to the placentas for a longer or shorter period.

Habit, etc.

The species may form dense leafless patches, less than an inch in height, on the surface of the ground (*C. enysii*), or large rounded masses 2in.–5in. high (*C. monroi*), or bushy leafless shrubs 2ft.–6ft. high (*C. australis*, *C. virgata*), or leafy shrubs 8ft.–9ft. high, with elegant pendulous branches (*C. odorata*). The tallest species is said to attain the height of 14ft., but is restricted to Lord Howe's Island.* Some species have elegant whip-like shoots, while others are inelegant bushes, with numerous short irregular branches. The whole aspect of certain species is completely altered when growing in situations open to the attacks of sheep.

The branches may be flat, ¾in. broad (*C. williamsii*), or almost filiform, terete or plano-convex, erect, distichous or spreading. Some species exhibit flattened branchlets at the beginning of the season, which become terete or plano-convex before the fruit reaches maturity; more slowly this characteristic is exhibited by many of the larger species, the branches of which almost invariably become terete with the development of the plant. The branchlets are usually striated

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* *C. exsul*, F. Muell. The only species not found in New Zealand.

or grooved, and rigid, but rarely flexuous and twining amongst other shrubs; lastly, they may be pubescent or glabrous, while very slender and very robust branchlets may sometimes be developed on the same plant.

LEAVES.

The leaves are alternate, and almost invariably of brief duration. In some species they are restricted to very young plants (*C. williamsii*), the mature state being always leafless; in others they are reduced to mere scales (*C. monroi*). The whole plant may be leafy until the maturation of the pod, when the leaves fall away in a few days (*C. odorata*); in species which exhibit this peculiarity the young plants are invariably leafy. The leaves are articulated at the junction of the petiole and blade, and may be 1-foliolate or pinnately 3–7-foliolate; the leaflets are sessile, and may be ovate, ovate-cuneate, or oblong-cuneate, orbicular, &c., but are always emarginate or obcordate In a few species they are glaucous beneath. In some species the leaves vary at different stages of growth—in the young state 3–5-foliolate, large, distant; but on mature specimens 1–3-foliolate, small, dense, and often fascicled (*C. flagelliformis*). Generally speaking, 3- or 1-foliolate leaves are the most common, but 1-, 3-, 5-, or 7-foliolate leaves may be found on the same plant. They are often pubescent in the young state.

INFLORESCENCE.

The flowers are developed in the alternate notches which are formed on each margin of the branchlets. They are usually arranged in racemes, which, by non-development of their internodes, are often much shortened, and frequently reduced to fascicles. The flowers are rarely solitary (*C. uniflora*), when the peduncles are elongated and very slender; or in 2–5-flowered racemes (*C. nana*), or 10–40-flowered (*C. odorata*). Occasionally the racemes are crowded, forming a false corymb. The rhachis and pedicels may be glabrous, puberulous, or silky; usually the pedicels carry one or more bractlets.

The flowers are constructed on the ordinary papilionaceous type, and vary in size from $\frac{3}{16}$in. to 1in. in length, and may be pendulous or erect. In colour they may be of a dull red or yellow, violet, or lighter shades of purple, or very pale purple with darker streaks and markings; very rarely they are pure white. Those of a red tinge are almost invariably produced on species of extremely dwarf habit.

The calyx may be truncate, campanulate, or almost tubular, while the sinus between the teeth may be broadly rounded, or simply acute. Sometimes the teeth are ex-

tremely minute. The whole calyx may be glabrous, silky, or puberulous.

The standard in most species is longer than broad, and is invariably reflexed; in a few species it is broader than long, the lobes being slightly auricled at the base. It may be entire or emarginate. The wings are usually linear and auricled, the length of the narrow claw varying in the different species; usually they are shorter than the keel, in a few species they exceed it. The keel is usually slightly longer than the style, which is enclosed by it at least before anthesis; in one or two instances the two petals of which it consists show an obvious want of cohesion at the apex. The stamens are invariably diadelphous, the filaments being slightly unequal in length, but the free portion is very short, so that the tube invariably encloses the style, except at its apex. The ovary may be nearly globose or oblong, and is rarely stipitate; the style may be straight or curved, and is usually naked, but in one or two species it is sparsely ciliated although not bearded (*C. kirkii*). The number of ovules is extremely variable. Normally the ovary is glabrous in all species of *Carmichaelia*, but occasionally several species develope few or many silky or pilose ovaries; this condition is, however, never permanent.*

The most valuable characters for differentiation of the species are afforded by the pods; in most species identification is difficult and uncertain in their absence. On the other hand, the pod alone is sufficient for positive identification in the majority of species (*C. monroi*, *C. williamsii*, *C. kirkii*, &c.) The pods may be erect (*C. odorata*), or spreading (*C. australis*), or pendulous (*C. monroi*). They may be turgid (*C. williamsii*), rounded (*C. kirkii*), or much compressed (*C. angustata*), elongate, elliptical, or subglobose, while the beak may be straight and well developed, oblique, or curved, or almost obsolete. The valves are excessively rugose or corrugated (*C. monroi*), faintly reticulate, or almost smooth (*C. australis*). In some species the pods are 1-seeded, others exhibit from two to twelve seeds in each pod. The seeds are reniform or subreniform, rounded or compressed, mottled or perfectly black (*C. nana*), rarely red (*C. australis*). In all the species the radicle exhibits a double flexure.

In most cases the seeds are liberated by the valves dehiscing along the replum and falling away; sometimes the seeds remain attached to the placentas for weeks, or even months, after the valves have fallen (*C. robusta*). In a few cases the valves open at the base or apex only, and are not separable for their entire length.

* The same phenomenon is often exhibited by *Festuca pratensis*, L.

Corallospartium, J. B. Armstrong. In Trans. N.Z. Inst., xiii. (1880), 333.

No technical definition of this genus was given by its author, but it differs essentially from *Carmichaelia* in the absence of the replum, and in the ovary and pod being invariably silky or pilose. It is a singular plant, with sparingly-branched cylindrical leafless stems, ¼in.–⅜in. in diameter, and 2ft.–4ft. high. The stems are yellow, with numerous deep longitudinal grooves, which are filled with short black lax tomentum. In the young state the stems are compressed or subterete, and produce a few unifoliolate leaves, which speedily fall away. The flowers are produced in dense fascicles; pedicels, bracteoles, and calyx being excessively woolly. The ovary is almost deltoid, rounded at the back, and excessively villous, and the pod is 1-seeded, with very thin valves.

Huttonella, n.g. T. Kirk.

The four species comprised in this small genus have the general habit of *Carmichaelia*, but the pods are indehiscent and turgid, the breadth usually exceeding the length, beak ascending or sharply turned upwards, sometimes forming a right angle with the axis of the pod. Seeds 1–3. Branchlets terete or compressed. Leaves 1–3-foliolate, but only known in a single species. One species is said to attain the height of 6ft.–8ft.; the others are of more humble stature, or prostrate.

The pods remain on the branches until the new flowers are produced, when they fall to the ground and decay, the valves being inseparable from the replum, which is usually imperfect.

(Described fully in "Student's Flora of New Zealand," now in the press.)

Notospartium, Hook. f. In Hook. Kew Jour., ix. (1857), 176, t. 3; Handbk. of N.Z. Fl., 51 (1864).

This remarkable genus consists of only two species, usually leafless shrubs, with slender, flexuous or pendulous, much-compressed narrow branchlets and small racemose flowers. The flowers differ but little from those of *Carmichaelia;* the wings are shorter than the hatchet-shaped keel; the ovary is linear, tapering into a long curved style, which is bearded on the upper surface. The pod is linear-elongate, shortly stipitate, straight or falcate, compressed, shortly beaked, torulose, 5–10-seeded, indehiscent. Unifoliolate leaves are developed on very young plants only.

One species was described by Sir Joseph Hooker as above; the other, which at present is not thoroughly understood, was included with *Carmichaelia kirkii* by Mr. J. B. Armstrong in his description of "*Carmichaelia gracilis,*" in Trans. N.Z. Inst., xiii. (1880), 336.

Distribution.

CARMICHAELIA.

It is remarkable that, while six species of *Carmichaelia* are common to the North and South Islands, no species extends over the entire area of the genus.

C. australis, R. Br., is found from the North Cape to the northern part of the Wellington District, and has a solitary outlying habitat in Queen Charlotte Sound, South Island. It ascends from sea-level to 3,000ft.

C. odorata, Col., occurs from the Ruahine Mountains to Cook Strait, with a single outlying habitat in Pelorus Sound, South Island.

C. flagelliformis, Col., is found from the East Cape to Milford Sound and Te Anau Lake, which can hardly be its extreme southern limit.

C. diffusa, Petrie, which is scarcely satisfactory as a species, has a single habitat in the Wellington District, and is also found in Canterbury and Otago, although remarkably local.

C. subulata, n.s., occurs on the East Cape, if the identification be correct, but is plentiful in Marlborough and Canterbury.

C. enysii, T. Kirk, is found on the Rangipo Plain, in the North Island, and in several localities in Canterbury and Otago.

C. nana, Hook. f., occurs from Taupo to Central Otago, and is probably more plentiful over a wider area than any other species.

The following are restricted to the North Island:—

C. williamsii, T. Kirk. Only found at the northern extremity of the East Cape; is the rarest and most local of all the species.

C. acuminata, n.s. White Rock, East Coast.

C. hookeri, n.s. Akitio River to Pencarrow Lagoon.

The following are only found in the South Island:—

C. uniflora, T. Kirk. Nelson; Canterbury; North Otago.

C. monroi, Hook. f. Marlborough to Otago; ascends to 4,500ft.

C. grandiflora, Hook f. Nelson, Canterbury, and Otago.

C. robusta, n.s. Canterbury Plains and Broken River basin.

C. petriei, n.s. Upper valley of the Clutha, Otago.

C. violacea, n.s. Coleridge Pass, Canterbury.

C. virgata, n.s. Otago(?), Southland. Attains the extreme south limit of the genus near the mouth of the Waiau River.

C. kirkii, Hook. f. Canterbury and Otago, but local.

C. angustata, n.s. Valley of the Buller, Nelson.

CORALLOSPARTIUM.

The only species is restricted to the mountains of Canterbury and Otago. Local, but more plentiful in Otago than in Canterbury.

HUTTONELLA.

H. juncea. From the East Cape, Rotorua, Taupo, to Canterbury and Central Otago. Possibly two species are included under this name.

H. curta. Waitaki Valley.

H. compacta. Central and Northern Otago; local.

H. prona. Broken River basin, Canterbury; 2,800ft.

NOTOSPARTIUM.

N. carmichaeliæ, Hook. f. Marlborough, from the Awatere to the southern boundary of the province, but, unhappily, has been extirpated in many habitats. Ascends to nearly 2,000ft. in ravines and valleys.

N. torulosum, n.s. From the Mason River, Nelson, to Mount Peel, Canterbury, but rare and local.

From the above it will be seen that seven species of *Carmichaelia* are common to both islands, but in very unequal degree; four having a wide distribution in one island, but only a solitary habitat in the other; the other three are more widely distributed in each. Three species are absolutely restricted to the North Island, two of them being remarkably local. Nine species are restricted to the South Island, two of which are found from Marlborough or Nelson to Otago, the remaining seven being decidedly local. The different species range from sea-level to nearly 5,000ft.

Corallospartium crassicaule, J. B. Armstrong, is local, and alpine or subalpine in the Districts of Otago and Southland.

Huttonella juncea, T. Kirk, is diffused from the East Cape to Central Otago, but is decidedly local.

The other three species are confined to the South Island, one being restricted to the Canterbury District and two to Otago.

Notospartium, Hook. f., as already stated.

The following is the arrangement of genera and species adopted in the forthcoming "Student's Flora of New Zealand":—

1. CORALLOSPARTIUM, J. B. Armstrong.

I. *C. crassicaule.*

2. CARMICHAELIA, R. Br.

I. *Nana.* Depressed leafless plants with fastigiate compressed branchlets, forming dense patches 1in.–4in. high. Flowers red.

* *Branchlets linear or narrow-linear, thin.*

Flowers solitary or racemose. Pods 1-seeded ..	1. *C. enysii.*
Flowers solitary, on long peduncles. Pods 3-seeded	2. *C. uniflora.*
Flowers racemose. Pods 2–4-seeded	3. *C. nana.*

** *Branchlets robust.*

Flowers racemose. Pods 6–12–seeded	*C. monroi.*

II. *Eucarmichaelia.* Erect or spreading species, 1ft.–8ft. high, leafless when in flower, except 7, 13, and 15. Flowers usually streaked with purple, rarely yellowish, white, pink, or deep purple.

* *Pods convex or turgid.*

A. Stems stout, erect, leafless, except 7 and 13.

Flowers few, 1in. long. Pods 1in. long, straight, erect	5. *C. williamsii.*
Flowers numerous, small. Pod oblong, seeds red	6. *C. australis.*
Leafy. Branchlets flat, $\frac{1}{12}$in.–$\frac{1}{4}$in. broad. Pods erect	7. *C. grandiflora.*
Branchlets robust. Racemes lax. Pods elliptic-oblong; seeds 3–6	8. *C. robusta.*
Branchlets spreading, terete. Pods broadly oblong; seeds 1 or 2	9. *C. petriei.*
Branchlets deeply grooved, terete. Flowers violet. Pod 2–4-seeded	10. *C. violacea.*
Branchlets almost filiform. Pods $\frac{1}{4}$in.–$\frac{1}{3}$in. long; 1-seeded..	11. *C. diffusa.*
Branchlets terete or plano-convex. Pods drooping, 1–2-seeded	12. *C. virgata.*
Leafy. Branchlets compressed or plano convex. Pods subulate	13. *C. subulata.*

B. Stems slender, flexuous, interlacing.

Leafy, racemes short. Pod with a straight subulate beak	14. *C. kirkii.*

** *Pods compressed.*

† Leafy when in flower.

Branchlets compressed, $\frac{1}{20}$in.–$\frac{1}{10}$in. broad, drooping. Pods in erect racemes, 2-seeded ..	15. *C. odorata.*
Branchlets compressed or terete. Pods many in spreading racemes	16. *C. angustata.*
Branchlets compressed, fastigiate, $\frac{1}{20}$in.–$\frac{1}{10}$in. broad. Seeds 2–4	17. *C. flagelliformis.*

†† Leafless or nearly so when in flower.

Branchlets compressed, $\frac{1}{12}$in. broad. Pods abruptly acuminate	18. *C. acuminata.*
Branchlets compressed, $\frac{1}{16}$in.–$\frac{1}{12}$in. broad. Pod ovate oblong, small	19. *C. hookeri.*

3. Huttonella, T. Kirk, n.g.

* *Leafless when in flower.*

Branchlets numerous, erect, terete. Racemes lax	1. *H. compacta.*

† *Racemes compact.*

Branchlets few, erect, terete. Pods broadly oblong, 2–3 seeded	2. *H. curta.*
Erect or prostrate. Branchlets terete or compressed. Pods 1–3 seeded	3. *H. juncea.*

** *Leafy when in flower.*

Prostrate. Branchlets compressed. Pods 1-seeded	4. *H. prona.*

4. NOTOSPARTIUM, Hook. f.

Branchlets drooping. Pods 3–5-seeded, crowded, straight	1. *N. carmichaeliæ.*
Branchlets flexuous or pendulous Pods 3–10-seeded, curved, distant	2. *N. torulosum.*

In conclusion, I venture to urge the advisability of students of the genus obtaining flowering and fruiting examples from the same plant before attempting to identify their specimens, and of observing the species over as wide an area as possible. It would be of the greatest benefit if many of the species could be raised from seed, so that the young plant could be observed from the seedling state, and the period of leaf duration exactly determined.

ART. XLVIII.—*Notes on the Botany of the East Cape District.*

By T. KIRK, F.L.S.

[*Read before the Wellington Philosophical Society, 17th February, 1897.*]

ON the 8th October, 1769, Banks and Solander, the first naturalists who visited New Zealand, landed at Poverty Bay, and collected numerous interesting plants not previously beheld by Europeans. They subsequently visited other localities in the East Cape district, and made good collections of the lowland species. It is, however, not a little remarkable that, nearly a hundred and thirty years after the district was visited by these botanists, we should have no systematic account of its flora and possess but a scanty acquaintance with its botanical riches. Until the settlement of Poverty Bay and Opotiki, however, the district was remarkably difficult of access, and could only be visited by taking passage in a small trading cutter. Upon landing the traveller had to rely wholly upon the hospitality and guidance of the Maoris. Even now roads are few and bad, while only a small portion of the district has been opened up in any way. Large steamers make regular trips between Gisborne and other ports, and small coasting-steamers occasionally touch at various bays between Gisborne and Opotiki. Still, as already intimated, a large portion of the district is in a state of nature, although the area of unsettled land is being reduced yearly.

The naturalists of Cook's first voyage landed at what is now Poverty Bay, and is referred to in the journals of the expedition as Te Oneroa,—although, as I learn from several friends, that name is properly applied to the long beach on the north side of the bay. Their next landing-place appears to have been Uawa, or Tolago Bay, and the last Tigadu, or Anaura. At these three places they gathered upwards of 250 out of the 360 species of flowering-plants and ferns collected during their stay in the colony.

About seventy years elapsed before the East Cape district was again visited by a naturalist. In 1838 the Rev. W. Colenso paid his first visit to the cape. In passing, I may express the pleasure felt by all present as we realise that, after an interval of nearly sixty years, he is still in the enjoyment of good health, and following his favourite pursuits with an amount of enthusiasm that might be envied by many younger men. Of his first visit no account appears to have been published, but in November, 1841, he landed at Wharekahika, now known as Hicks Bay, and appears to have occupied about three weeks in travelling to Poverty Bay, whence he struck inland in a slightly south-easterly direction to Waikaremoana, a large lake of irregular shape situate at an altitude of 2,015ft. above sea-level; thence he travelled eastward to Lake Tarawera. During his examination of the district he made several additions to the flora, amongst them being the plant now known as *Pittosporum ralphii*, T. Kirk, of which he writes, "Waipiro to a short distance beyond Tapatahi. I discovered . . . a species of *Pittosporum*, which at first I took for *P. umbellatum*, Banks, but have since discovered it to be a distinct and probably a new species, ranking between *P. crassifolium* and *P. umbellatum*" (p. 17). It was during this journey that he discovered the beautiful fern *Todea superba*, now probably the most widely known of all the New Zealand species. In 1844 Mr. Colenso published in Launceston an interesting account of this journey, under the title of "Excursion in the Northern Island of New Zealand in the Summer of 1841–42"—a work which has become extremely rare, and from which the above extract is taken. I have been unable to find any published account of his ascent of Hikurangi, where he was the first to discover such remarkable plants as *Ranunculus insignis*, Hook. f.; *Aciphylla colensoi*, Hook. f.; *Olearia colensoi*, Hook. f.; *Veronica tetragona*, Hook., &c., which attain their extreme northern limit on this lofty peak.

The late Dr. Sinclair landed on the East Cape about 1849 or 1850, where he discovered *Carmichaelia juncea*, Hook. f., but does not appear to have travelled far inland. For more than twenty-five years my valued friend the Bishop of Waiapu has travelled through the district and carefully noted the

chief features of the vegetation. Amongst many remarkable discoveries made by him must be specially mentioned the occurrence of *Carmichaelia williamsii* at Hicks Bay, *Archeria racemosa* at Te Whetu Matarau, and *Pisonia brunoniana* at the East Cape. I am indebted to him not only for numerous specimens, but for a vast amount of general information respecting the plants of the district, and especially for a catalogue of three hundred flowering-plants and ferns collected by him during his frequent itinerations. It is upon this list and one of the plants collected by Banks and Solander that the catalogue of East Cape plants presented herewith is chiefly based.

I am also indebted to Mr. S. Dodgshun, of Waipiro, for a valuable collection of plants from the peak of Hikurangi; to my son, Mr. H. B. Kirk, for *Thelymitra colensoi* and other rarities; and to Mr. J. B. Lee, of Waipiro, for specimens collected during the past two years.

Mr. H. Hill, Inspector of Schools to the Education Board of Hawke's Bay, has made several interesting discoveries during his official journeys through the district, the most noteworthy being *Peperomia reflexa*, Dietrich, and *P. muricatulata*, Col., both new to the colony. He has recently discovered a remarkable habitat for *Dactylanthus taylori*, Hook. f.

Mr. A. Hamilton visited Waikaremoana and other parts of the district several years ago, when he collected a few plants not previously known to occur in the district.

I have twice visited the district, but on each occasion my time was so closely taken up by official duties that the opportunities for botanical investigation were extremely brief, and only permitted the collection of a few plants not previously recorded. Urgent duties have hitherto prevented my carrying out a long-cherished intention of making a detailed examination of the district; so that the catalogue of flowering-plants and ferns now submitted is largely due to the labours of others; it seems, however, too valuable to be longer hidden, and is therefore, after much delay, arranged in a form which will render it available for use by my fellow-workers.

The East Cape district comprises the country extending from Opotiki, Cape Runaway (37° 30′ south), and the East Cape to the Mahia Peninsula (39° 15′ south), so that on the east, north, and south it is bounded by the sea. On the west it runs into the vast stretch of forest country which extends to the Whakatane Mountains, and is known as the Urewera country, or the Land of Tuhoe.

Much of the country is very broken, the mountains culminating in Hikurangi, 5,606ft., the highest peak north of

Tongariro. Large portions are still covered with dense forest, of which *Vitex lucens* is an important constituent in the northern portion of the district. A good road runs from Gisborne for about twenty-five miles towards the Motu Forest, whence a bridle-track is continued to Opotiki, passing through some of the most striking forest scenery in the North Island. The most important lake is Waikaremoana; it is 2,015ft. above sea-level, and of most irregular shape—about eleven miles in length, and eight in its greatest breadth. It is said to be the most beautiful lake in the North Island, the cliffs by which it is surrounded rising in some places to fully 1,100ft. above its level. Waikare-iti, a small lake 3,122ft. above sea-level, is supposed to be the highest lake in the island.

The following description of the "road" between Opotiki and Gisborne, written by Mr. H. B. Kirk, will give the reader a good idea of the broken character of the northern part of the district:—

"The traveller from Opotiki to Gisborne has a choice of two roads—to use the name that charity gives with more or less—generally much less—appositeness. If he decides to go by the coastal road he proceeds along the beach for about nine miles, and then at once realises that he has reached the point at which the hills have come in good earnest to the shore. He follows a well-made bridle-track over the spurs above the sea until he reaches Torere and, later, Hawai. There is now no made road, a road between Hawai and the Motu River having been allowed to become impassable. The shingle beach is the only road, and at high water, or in bad weather, it is a most unpleasant one. Above the beach rise cliffs and hills, the former almost or quite perpendicular. To these cliffs the pohutukawa clings with wonderful persistency. The Motu River has a bad reputation, and deserves it. It is the Waimakariri of the Bay of Plenty. At the mouth its bed is about three-quarters of a mile wide, but the river so seldom occupies the whole of it, that tall manuka and light bush are allowed to form patches in many places. From the Motu there is again a bridle-track, skirting generally the tops of the cliffs, and running through forests of pohutukawa to Omaio. Here *Carmichaelia williamsii* is found. Just beyond Omaio the Haparapara River is crossed, and the traveller, keeping generally to the beach, which becomes more tolerable as the hills recede a little, comes to Te Kaha Point, still fertile after perhaps thirty years' crops of maize have been grown with no rotation. From Te Kaha the track, where there is one, continues to skirt the coast. Here the numbers and warlike habits of the old population are constantly recalled to mind by deep trench and bank cutting off all suitable points of land as

fortifications. In many of the trenches pohutukawas a foot or more in diameter are now growing. Two small rivers are passed before the Raukokore is reached; the crossing here may or may not be troublesome. After passing Raukokore, Oreti Point is reached, flat, open, and occupied by a farm. From Oreti there is a fairly good track to the Whangaparaoa River, which enters the sea near Cape Runaway. Here is the place to leave the coast, and the river-bed is followed for some little distance, until, rising at first gradually and then so rapidly that the method of progress is almost climbing, the traveller stands on the clay hills that separate the waters of the Bay of Plenty from those of Hicks Bay. The vegetation is striking—beech, tanekaha, toro, and *Dracophyllum strictum.*

"Looking to the right is seen perhaps the most extended stretch of hill-country in the whole of New Zealand. Rounded hills, bush-covered for the most part, extend as far as one can see. Among them, on the right, rises Mount Hardy (Rangipoua), 1,332ft., and on the left Hikurangi and his attendant mountains.

"Leaving the ridge, the track leads to the waters of the Wharekahika River, or Wai-kohu, the bed of which is the road for the next fourteen miles. Men that have had patience to count say that there are 117 crossings to be made; but that is a matter of exigency. At any rate, there are crossings enough to make the average traveller very tired of river work. From Hicks Bay a bridle-track leads over high hills to Kawakawa Beach (of heavy shingle), passing the Waerenga and the Karakatawhero Rivers. The native settlement of Te Arawa is at the foot of very high limestone cliffs. Here, in the school-grounds, is probably what is the largest pohutukawa-tree in New Zealand. It is known as Te Waha-o-Rerekohu ("the mouth of Rerekohu"). Rerekohu, an ancestor of the present chief, Te Hatiwira Houkamau, planted this tree. Six generations have intervened between Rerekohu and Te Hatiwira. Leaving Te Arawa, the Awatere River, well deserving its name, is crossed. From this point there is a land road, passable in summer, to Wai-o-matatini, on the Waiapu River. The coastal track is on the beach until the East Cape is passed. Then the great Wakori Bluff has to be climbed, and at length the track reaches the shingle beach at the mouth of the Waiapu. The crossing of the Waiapu may be a simple matter, or it may take a man and his horse all their time to cheat the coroner here. A few miles inland two rivers, the Mata and the Tapuwaeroa, unite to form the Waiapu; they drain the two sides of the Hikurangi mass. The great eastern branch of the southern mountain-range, passing into the North Island as the Rimutakas, and known as it runs northward

as Tararua, Ruahine, Kaweka, Raukumara, here ends in bold mountain masses worthy of a range that has run such a course. Above all is Hikurangi (5,606ft.); on the eastern side is Aorangi, somewhat lower; and on the western is Whanakao (4,323ft.). Close to Hikurangi is a hill, known locally as Little Hikurangi, that looks as if it belonged to a lunar landscape.

"Leaving the Waiapu River, the track improves as it runs southwards, although it often passes over very high hills, until it reaches Tolago. The highest hill is probably Tawhiti, 1,680ft. *Calceolaria sinclairii* grows almost at the top of it. Inland from Tawhiti are the Waipiro hot springs, rising through rock-salt, and encouraging a growth of *Samolus repens* and other littoral plants. Close to Tolago (or Uawa) is Cook's Cove, where what is known as Cook's well is still to be seen.* Between Tolago and Gisborne there is a road along which an adventurous man drives a weekly coach.

"The alternative road, the Motu track, is only 110 miles in length. It passes over lofty ranges, along rocky precipices, and through dense bush, the scenery throughout being almost as beautiful and striking as that of the coast road. The happy traveller to-day finds the Motu bridged. In former times he had to cross by a ford on a bottom of much-worn papa rock, with the cold water running like a mill-race, at one moment not above the horse's fetlocks, at the next up to the shoulder."

The flora of the district, although most luxuriant, is probably less rich in species than might have been anticipated, as portions of the area are clothed with *Leptospermum*, *Cassinia*, and *Pteris*. The extensive forest districts exhibit great variety and luxuriance, differing but little from the best forest of the North Auckland district, except in the total absence of kauri (*Agathis australis*, Salisb.). Perhaps the most remarkable characteristic is exhibited by the puriri (*Vitex lucens*, T. Kirk), which is extremely luxuriant, and attains large dimensions in many localities, features of great interest when it is remembered that this subtropical tree finds its extreme south-eastern limit on the East Cape peninsula.

The appended catalogue of flowering-plants and ferns known to occur within the limits of the district comprises about five hundred species, but cannot be considered an adequate representation of the flora. When Aorangi, Hikurangi, and other peaks, with the high country about Waikaremoana

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* See Trans. N.Z. Inst., x., "On a Cavern near Cook's Well at Tolago Bay, and on a Tree found there," by the Rev. W. Colenso, F.R.S.; also, an article on the visit of Cook to Poverty Bay, by Bishop Williams, in vol. xxi., 389.

and the low-lying Mahia Peninsula are examined in detail, the number of species will probably be raised to six hundred and fifty or seven hundred, the additions consisting almost exclusively of flowering-plants.

A few plants of considerable interest are endemic in the district,—

Carmichaelia williamsii, *T. Kirk.*
Coprosma solandri, *n.s.*
Senecio perdicioides, *Hook. f.*
Peperomia muricatulata, *Col.*
Peperomia reflexa, *Dietrich.*

The last, however, has a wide distribution outside New Zealand.

Senecio banksii, *Hook. f.*

This is also known to occur on the Mokohinou Islands, but not elsewhere.

But the chief interest of the district arises from its exhibiting such a remarkable intermixture of plants characteristic of the extreme north of the colony with others of a peculiarly southern type. Nowhere else do we find associated genera offering such a remarkable contrast when considered with regard to their geographical distribution as *Pisonia* and *Euphrasia*, *Sideroxylon* and *Aciphylla*, *Persoonia* and *Gentiana*, *Vitex* and *Calceolaria;* while the number of species that attain their northern or southern limits within its boundaries is perhaps larger than could be found in any other district of similar area in the North Island, as will be seen from the following list:—

SPECIES ATTAINING THEIR EXTREME SOUTHERN LIMITS IN THE EAST CAPE DISTRICT.

Pittosporum umbellatum, *Banks and Sol.*
" crassifolium, *A. Cunn.*
Metrosideros tomentosa, *A. Cunn.* (On the East Coast.)
Pseudopanax lessonii, *C. Koch.*
Siegesbeckia orientalis, *L.*
Bidens pilosa, *L.*
Senecio banksii, *Hook. f.*
Archeria racemosa, *Hook. f.*
Sideroxylon costatum, *F. Muell.*
Vitex lucens, *T. Kirk.*
Pisonia brunoniana, *Endl.*
Beilschmeidia tarairi, *Benth. and Hook. f.*
Persoonia toro, *A. Cunn.*
Gahnia arenaria, *Hook. f.*
" lacera, *Stend.*
Paspalum scrobiculatum, *L.*

Species attaining their Extreme Northern Limits in the East Cape District.

Ranunculus insignis, *Hook. f.*
Viola cunninghamii, *Hook. f.*
Hoheria angustifolia, *Raoul.*
Coriaria thymifolia, *Humb.*
Huttonella juncea, *T. Kirk.*
Carmichaelia subulata, *T. Kirk.*
„ flagelliformis, *Col.*
Sophora tetraptera, *Acton, var.* grandiflora.
Epilobium erubescens, *Haussk.*
Oreomyrrhis andicola, *Endl., var.* colensoi.
Aciphylla squarrosa, *Forst.*
„ colensoi, *Hook. f.*
Ligusticum aromaticum, *Hook. f.*
Angelica geniculata, *Hook. f.*
Panax sinclairii, *Hook. f.*
Coprosma tenuifolia, *Cheesem.*
„ cuneata, *Hook. f.*
Celmisia spectabilis, *Hook. f.*
Olearia colensoi, *Hook. f.*
„ nitida, *Hook. f.*
„ ilicifolia, *Hook. f.*
Cassinia fulvida, *Hook. f.*
Helichrysum bellidioides, *Willd.*
„ leontopodium, *Hook. f.*
Microseris forsteri, *Hook. f.*
Senecio bidwillii, *Hook. f.*
Dracophyllum strictum, *Hook. f.*
„ longifolium, *R. Br.*
„ recurvum, *Hook. f.*
„ subulatum, *Hook. f.*
Gentiana bellidifolia, *Hook.*
„ pleurogynoides, *Griseb.*
Myosotis spathulata, *Forst.*
Calceolaria sinclairii, *Hook. f.*
„ repens, *Hook. f.*
Mazus pumilio, *R. Br.*
Veronica tetragona, *Hook.*
„ lyallii, *Hook. f.*
Euphrasia cuneata, *Forst.*
„ revoluta, *Hook. f.*
Plantago spathulata, *Hook. f.*
„ varia, *R. Br.*
Muhlenbeckia ephedroides, *Hook. f.*
Loranthus colensoi, *Hook. f.*
Fagus solandri, *Hook. f.*

Fagus cliffortioides, *Hook. f.*
Urtica ferox, *Forst.*
Bulbophyllum tuberculatum, *Col.*
Alopecurus geniculatus, *L.*
Stipa arundinacea, *Benth. and Hook. f.*
Deyeuxia avenoides, *Buch.*
Alsophila colensoi, *Hook. f.*
Hypolepis millefolium, *Hook.*
Lomaria alpina, *Spreng.*
Asplenium richardi, *Hook. f.*

The names of genera which find their northern or southern limits in the district are printed in larger type.

There can be no doubt that a detailed examination of the botany of the district would add several species to the preceding lists.

CATALOGUE OF FLOWERING PLANTS AND FERNS OBSERVED IN THE EAST CAPE DISTRICT.

RANUNCULACEÆ.

Clematis indivisa, Willd
" hexasepala, *DC.* Banks and Sol. !
Clematis marata, *J. B. Armst* W. L. W ! The northern limit of the species.
Clematis fœtida, *Raoul.*
" parviflora, *A. Cunn.*
Ranunculus insignis, *Hook. f.* Hikurangi: S. Dodgshun! Colenso, *ex* Handbk. The extreme northern habitat of this alpine species.
Ranunculus hirtus, *Banks and Sol. !*
" macropus, *Hook. f.*
" rivularis, *Banks and Sol. !*
" acaulis, *Banks and Sol. !*

MAGNOLIACEÆ.

Drimys axillaris, *Forst.*

CRUCIFERÆ.

Nasturtium terrestre, *R. Br.* Banks and Sol. !
Cardamine hirsuta, *L., var.* debilis, *Banks and Sol. !*
" stylosa, *DC.* Tolago Bay: Banks and Sol. !
Lepidium oleraceum, *Forst.* Te Oneroa, Tolago, Tigadu: Banks and Sol. !

VIOLARIEÆ.

Viola cunninghamii, *Hook. f.*
" filicaulis, *Hook. f.* Colenso.
Melicytus ramiflorus, *Forst.* Banks and Sol. !
" lanceolatus, *Hook. f.*
" micranthus, *Hook. f.*

PITTOSPOREÆ.

Pittosporum tenuifolium, *Banks and Sol. !*
„ ralphii, *T. Kirk.* Banks and Sol. !
„ crassifolium, *A. Cunn.*
„ „ *var.* strictum.
„ umbellatum, *Banks and Sol. !*
„ eugenioides, *A. Cunn.*
„ cornifolium, *A. Cunn.* Banks and Sol. !

CARYOPHYLLEÆ.

Stellaria parviflora, *Banks and Sol. !*

HYPERICINEÆ.

Hypericum japonicum, *Thunb.* Banks and Sol. !

MALVACEÆ.

Plagianthus divaricatus, *Forst.* Banks and Sol. !
„ betulinus, *A. Cunn.*
Hoheria populnea, *A. Cunn., var.* lanceolata.
Hoheria populnea, *var.* angustifolia. Probably the extreme northern limit of this variety.
Hibiscus trionum, *L.* Banks and Sol. !

TILIACEÆ.

Entelea arborescens, *R. Br.* Banks and Sol. !
Aristotelia racemosa, *Hook. f.* Banks and Sol. !
Elæocarpus dentatus, *Vahl.* Banks and Sol. !
„ hookerianus, *Raoul.*

LINEÆ.

Linum monogynum, *Forst.* Banks and Sol. !

GERANIACEÆ.

Geranium dissectum, *L., var.* carolinianum. Banks and Sol. !
„ microphyllum, *Hook. f.* Banks and Sol. !
„ molle, *L.*
Pelargonium australe, *Willd.* Banks and Sol. !
Oxalis corniculata, *L.* Banks and Sol. !
„ magellanica, *Forst.*

RUTACEÆ.

Melicope ternata, *Forst.* Banks and Sol. !
„ simplex, *A. Cunn.*

MELIACEÆ.

Dysoxylum spectabile, *Hook. f.* Banks and Sol. !

OLACINEÆ.

Pennantia corymbosa, *Forst.*

RHAMNEÆ.

Pomaderris phylicifolia, *Lodd.* Banks and Sol. !
Discaria toumatou, *Raoul.* Banks and Sol. !

SAPINDACEÆ.

Dodonæa viscosa, *Jacq.* Banks and Sol.!

Alectryon excelsum, *DC.* Banks and Sol.!

ANACARDIACEÆ.

Corynocarpus lævigata, *Forst.* Banks and Sol.!

CORIARIEÆ.

Coriaria ruscifolia, *L.* Banks and Sol.!

" thymifolia, *Humb.* Poverty Bay: W. L. W.!

LEGUMINOSÆ.

Carmichaelia williamsii, *T. Kirk.* Te Kaha to Hicks Bay: W. L. W.! This handsome species is not known elsewhere.

Carmichaelia australis, *R. Br.* Banks and Sol.!

" subulata, *T. Kirk.* W. L. W.: J. B Lee.

" flagelliformis, *Col.*

Huttonella juncea, *T. Kirk.* East Cape: Sinclair, *ex* Handbk.

Clianthus puniceus, *Banks and Sol.!* Originally discovered at Tolago and Tigadu. Bishop Williams informs me that it is still found at Anaura and on one or two small islands in the vicinity; also inland. The fine plate in the Banksian collection represents the form with obtuse wings, distinguished by Colenso as *C. maximus.* The Banksian specimens in my possession are characterized by pointed wings, while others collected at Anaura by Bishop Williams are intermediate.

Sophora tetraptera, *Ait*, *var.* grandiflora.

" *var.* microphylla, *Banks and Sol.!*

ROSACEÆ.

Rubus australis, *Forst.*

" cissoides, *A. Cunn.*

" schmidelioides, *A. Cunn.* Banks and Sol.!

Potentilla anserina, *L.*

Geum urbanum, *L.*, *var.* strictum.

Acæna sanguisorbæ, *Vahl.* Banks and Sol.!

SAXIFRAGEÆ.

Quintinia serrata, *A. Cunn.*

Ixerba brexioides, *A. Cunn.*

Carpodetus serratus, *Forst.*

Weinmannia silvicola, *Banks and Sol.!*

" racemosa, *Forst.*

CRASSULACEÆ.

Tillæa sieberiana, *Schult.* Banks and Sol.!

DROSERACEÆ.

Drosera binata, *Labill.*

" auriculata, *Backh.* Banks and Sol.!

HALORAGEÆ.

Haloragis alata, *Jacq*. Banks and Sol. !
„ micrantha, *R. Br.*
Myriophyllum, *sp*. Waikaremoana. Colenso.
Callitriche muelleri, *F. Sond.*

MYRTACEÆ.

Leptospermum scoparium, *Forst*. Banks and Sol. !
„ ericoides, *A. Rich*. Banks and Sol. !
Metrosideros florida, *Sm*. Banks and Sol. !
„ albiflora, *Banks and Sol.*
„ hypericifolia, *A. Cunn*. T. K.
„ robusta, *A. Cunn.*
„ tomentosa, *A. Cunn*. The most southern habitat on the East Coast.
„ scandens, *Banks and Sol. !*
Myrtus bullata, *Banks and Sol. !*
„ obcordata, *Hook. f*. W. L. W. !
„ pedunculata, *Hook. f*. W. L. W. !

ONAGRARIEÆ.

Fuchsia excorticata, *L. f*. Banks and Sol. !
„ colensoi, *Hook. f*. W. L. W. !
Epilobium nummularifolium, *A. Cunn*. Banks and Sol.
„ „ *var.* pedunculare.
Epilobium junceum, *Sol*. Banks and Sol. !
„ pallidiflorum, *Sol.*
„ billardierianum, *Ser.*
„ pubens, *A. Rich*. W. L. W. !
„ alsinoides, *A. Cunn*. W. L. W. !
„ rotundifolium, *G. Forst.*
„ erubescens, *Haussk*. Summit of Hikurangi: S. Dodgshun! Apparently the most northern habitat of this species.

PASSIFLOREÆ.

Passiflora tetrandra, *Banks and Sol. !*

CUCURBITACEÆ.

Sicyos angulatus, *L*. Banks and Sol. !

FICOIDEÆ.

Mesembryanthemum australe, *Soland*. Banks and Sol. !
Tetragonia expansa, *Murray*. Banks and Sol. !
„ implexicoma, *Miq*. W. L. W. !

UMBELLIFERÆ.

Hydrocotyle asiatica, *L*. Banks and Sol. !
„ heteromeria, *DC*. Banks and Sol. !
„ novæ-zelandiæ, *DC*. Banks and Sol. !
„ moschata, *Forst.*
Apium australe, *Thouars*. Banks and Sol. !

Oreomyrrhis andicola, *Endl*, *var.* colensoi. T. K.
Aciphylla squarrosa, *Forst.*
" colensoi, *Hook. f.* S. Dodgshun!
Both species appear to reach their northern limit on Hikurangi, which is also the northern limit of the genus.
Ligusticum aromaticum, *Hook f* Hikurangi: S. Dodgshun!
Angelica geniculata, *Hook. f.* Colenso
Angelica rosæfolia, *Hook.* Banks and Sol.!
Daucus brachiatus, *Sieber.* Banks and Sol!

ARALIACEÆ.

Panax edgerleyi, *Hook. f.* W. L. W!
" anomalum, *Hook.* Waipiro: J B. Lee!
" arboreum, *Forst.*
" colensoi, *Hook. f* Hikurangi: S. Dodgshun!
" sinclairii, *Hook. f.* East Cape · Sinclair.
Pseudopanax crassifolium, *C. Koch.* Banks and Sol.!
" ferox, *T. Kirk.* W. L. W.!
" lessonii, *C. Koch.* Banks and Sol.!
Schefflera digitata, *Forst.* Banks and Sol.!

CORNEÆ.

Griselinia lucida, *Forst.* Banks and Sol.!
" littoralis, *Raoul.* W. L W.!
Corokia cotoneaster, *Raoul.*

CAPRIFOLIACEÆ.

Alseuosmia macrophylla, *A. Cunn.* T. K.!
" quercifolia, *A. Cunn.* W. L. W.!

RUBIACEÆ.

Coprosma lucida, *Forst.* Banks and Sol.!
" grandifolia, *Hook. f.* T. K.!
" baueriana, *Endlich.* Banks and Sol.!
" robusta, *Raoul.* Banks and Sol.!
Coprosma tenuifolia, *Cheesem.* Specimens of this species are mixed with *C. robusta* in the Banksian collection. It is found in the adjacent Urewera country.
Coprosma fœtidissima, *Forst.* W. L. W.!
" spathulata, *A. Cunn.* Banks and Sol.!
" rotundifolia. W. L. W.!
" crassifolia, *Col.* W. L. W.!
" areolata, *Cheesem.* T. K.
" tenuicaulis, *Hook. f.*
" rhamnoides, *A. Cunn.* W. L. W.!
" propinqua, *A. Cunn.*
" colensoi, *Hook. f.* Waikaremoana: W. L. W.!
" acerosa, *Col.* Banks and Sol.!

Coprosma solandri, *n.s.* Much branched, branches stout, obscurely tetragonous, rigid; branchlets numerous, short, erect; bark whitish, setose. Leaves sessile, very coriaceous, linear-lanceolate, about ⅛in. long, $\frac{1}{10}$in. broad, acute or apiculate, sparsely ciliate, laxly imbricating, erect, midrib sunk on both surfaces. Stipules setose, ciliate, loosely sheathing. Flowers not seen. Fruit solitary, terminal; involucel of two short leaves with dilated bases, globose-ovoid, $\frac{4}{16}$in. to $\frac{5}{16}$in. long, the persistent calyx-lobes acute, ciliate, connivent. East Cape district. Herb. Banks. Apparently related to *C. linariifolia* and *C. colensoi*, but its affinities cannot be precisely indicated in the absence of flowers.

Coprosma cuneata, *Hook. f.* Mount Hiteurangi: Colenso.

Nertera dichondræfolia, *Hook. f.* J. B. Lee!

„ cunninghamii, *Hook. f.* W. L. W.!

Galium tenuicaule, *A. Cunn.* Banks and Sol.!

„ umbrosum, *Forst.*

COMPOSITÆ.

Olearia colensoi, *Hook. f.* Hikurangi: Colenso; S. Dodgshun! The northern limit of this species.

„ furfuracea, *Hook. f.* W. L. W.!

„ nitida, *Hook. f.* J. B. Lee! The northern limit of the species.

„ ilicifolia, *Hook. f.* W. L. W.! The northern limit of the species.

„ cunninghamii, *Hook. f.* W. L. W.!

„ forsteri, *Hook. f.* W. L. W.! The northern limit of the species.

„ solandri, *Hook. f.* Banks and Sol.!

Celmisia incana, *Hook. f.* Hikurangi: Colenso; S. Dodgshun!

„ spectabilis, *Hook. f.* Hikurangi: Colenso; S Dodgshun! The northern limit of the species.

„ longifolia, *Cass.* W. L. W.!

Vittadinia australis, *A. Rich.* Banks and Sol.!

Lagenophora forsteri, *DC.* Banks and Sol.!

Siegesbeckia orientalis, *L.* Banks and Sol. As this was collected by Banks and Solander, it has evidently fair claim to be considered indigenous.

Bidens pilosa, *L.*

Cotula coronopifolia, *L.*

Craspedia fimbriata, *DC.* S. Dodgshun.

Cassinia retorta, *A. Cunn.* Banks and Sol.!

„ fulvida, *Hook. f.* W. L. W.!

Helichrysum, glomeratum, *Benth. and Hook. f.*

Helichrysum bellidioides, *Hook. f.* Mount Hikurangi: S. Dodgshun.!

Helichrysum keriense, *A. Cunn.* W. L. W.!
" " *var.* linifolia.
Helichrysum leontopodium, *Hook. f.* Mount Hikurangi. Colenso; S. Dodgshun! The extreme northern limit of this fine plant.
Gnaphalium luteo-album, *L.* Banks and Sol.!
" involucratum, *Forst.* Banks and Sol.!
" collinum, *Labill.* Banks and Sol.!
Erechtites prenanthoides, *DC.* Banks and Sol.!
" arguta, *DC.* Banks and Sol.!
" scaberula, *Hook, f.* Banks and Sol.!
" quadridentata, *DC.* Banks and Sol.!
Senecio dimorphocarpos, *Col.* Banks and Sol.!
" lautus, *Forst.* Banks and Sol.!
Senecio banksii, *Hook. f.* Banks and Sol.! So far as known, this species is confined to the East Cape district, with the exception of a solitary habitat on the Mokohinou Islands. In all probability it will be found on the Little Barrier Island.
Senecio glastifolius, *Hook. f.*, not of *Linn. f.*
Senecio kirkii, *Hook. f.* W. L. W.!
Senecio perdicioides, *Hook. f.* Banks and Sol. From Hicks Bay to the southern portion of the Mahia Peninsula, in certain localities. W. L. W.! Confined to the district.
Senecio bidwillii, *Hook. f.* Mount Hikurangi: Colenso; S. Dodgshun! The extreme northern limit of this alpine species.
Brachyglottis repanda, *Forst.* Banks and Sol.!
Microseris forsteri, *Hook. f.* Banks and Sol.
Taraxacum dens-leonis, *Desf.*, *var.* glabratum. Banks and Sol.! This plant has now become very rare, and has been seen by few New Zealand botanists.
Sonchus oleraceus, *L.*, *var.* aspera Banks and Sol.!

CAMPANULACEÆ.

Wahlenbergia gracilis, *A. Rich.* Banks and Sol.!
Lobelia anceps, *Thunb.* Banks and Sol.!
Pratia angulata, *Hook. f.* Banks and Sol.!
Selliera radicans, *Cav.*

ERICEÆ.

Gaultheria antipoda, *Forst.*
Gaultheria oppositifolia, *Hook. f.* Between Whangaparaoa and Hicks Bay: W. L. W.!

EPACRIDEÆ

Cyathodes acerosa, *R. Br.*
Leucopogon fasciculatus, *A. Rich.*
" fraseri, *A. Cunn.*

Archeria racemosa, *Hook. f.* On the steep slopes of Te Whetu Matarau, Te Araroa: W. L. W.! The extreme southern limit of this rare plant.

Dracophyllum latifolium, *A. Cunn.*

„ strictum, *Hook. f.* Whangaparaoa: W. L. W.!

„ squarrosum, *Banks and Sol.!*

„ recurvum, *Hook. f.* Mount Hikurangi: Colenso.

„ longifolium, *R. Br.* W. L. W.!

„ urvilleanum, *A. Rich.*

„ subulatum, *Hook. f.* W. L. W.!

MYRSINEÆ.

Myrsine salicina, *Heward.* W. L. W.!

„ urvillei, *A. DC.* Banks and Sol.!

PRIMULACEÆ.

Samolus repens, *Pers.* Banks and Sol.!

SAPOTÆ.

Sideroxylon costatum, *F. Muell.* East Cape, Marau Point. Tolago Bay; rare: W. L. W.! The extreme southern limit of this fine tree.

JASMINEÆ.

Olea cunninghamii, *Hook. f.* J. B. Lee.!

„ lanceolata, *Hook. f.* W. L. W.!

„ montana, *Hook. f.* W. L. W.!

APOCYNEÆ.

Parsonsia albiflora, *Raoul.*

„ rosea, *Raoul.*

LOGANIACEÆ.

Geniostoma ligustrifolium, *A. Cunn.* Banks and Sol.!

GENTIANEÆ.

Gentiana bellidifolia, *Hook.* Mount Hikurangi: S. Dodgshun!

„ pleurogynoides, *Griseb.* Mount Hikurangi. S. Dodgshun!

BORAGINEÆ.

Myosotis spathulata, *Forst.* Banks and Sol.!

„ forsteri, *Roem. and Sch.* Banks and Sol.!

Exarrhena petiolata, *Hook. f.* W. L. W.!

CONVOLVULACEÆ.

Convolvulus sepium, *L.* Banks and Sol.!

„ tuguriorum, *Forst.* Banks and Sol.!

„ soldanella, *L.* Banks and Sol.!

Dichondra repens, *Forst.* Banks and Sol.!

SOLANEÆ.

Solanum aviculare, *Forst.*
  „ nigrum, *L.*

SCROPHULARINEÆ.

Calceolaria sinclairii, *Hook.* Hicks Bay to Mohaka, chiefly on the eastern side of the district; on a stream running into the Motu: W. L W. !
Calceolaria repens, *Hook. f.* W. L. W. !
Mimulus repens, *R. Br.* W. L. W. !
Mazus pumilio, *R. Br.* W. L. W. !
Gratiola sexdentata, *A. Cunn.* Banks and Sol. !
Veronica macroura, *Hook. f.* Colenso. W. L. W. !
  „ salicifolia, *Forst.* Banks and Sol. !
  „ macrocarpa, *Vahl.* Banks and Sol. !
  „ parviflora, *Vahl.* W. L. W. !
  „ tetragona, *Hook.* Mount Hikurangi: Colenso; S. Dodgshun ! The northern limit of the species.
  „ lyallii, *Hook. f.* Mount Hikurangi: S. Dodgshun ! The extreme northern limit of the species.
Ourisia macrophylla, *Hook.* Mount Hikurangi and other localities: J. B. Lee ! W. L. W. ! The northern limit of both species and genus.
Euphrasia cuneata, *Forst.* Banks and Sol. ! The northern limit of both species and genus.
Euphrasia revoluta, *Hook. f.* Mount Hikurangi: S. Dodgshun ! The extreme northern limit.

VERBENACEÆ.

Vitex lucens, *T. Kirk* (Vitex littoralis, *A. Cunn.*, not of *Dcne.*). Banks and Sol. ! Finds its southern limit on the east coast at the eastern point of Table Bay. W. L. W. !
Myoporum lætum, *Forst.* Banks and Sol. !
Avicennia officinalis, *L.* Near Opotiki: W. L. W. !

LABIATÆ.

Mentha cunninghamii, *Benth.* W. L. W. !

PLANTAGINEÆ.

Plantago spathulata, *Hook. f.* Banks and Sol. ! W. L. W. ! The northern limit of the species.
Plantago varia, *R. Br.* Banks and Sol. ! This species occurs in various localities in the colony, but hitherto has been considered introduced.
Plantago raoulii, *Dec.* W. L. W. !

NYCTAGINEÆ.

Pisonia brunoniana, *Endlich.* On the landward face of the isolated hill which forms the East Cape: W. L. W. ! The extreme southern habitat of the species.

Chenopodiaceæ.

Chenopodium glaucum, *L.*, *var.* ambiguum.
Atriplex billardieri, *Hook. f.* Anaura Beach: W. L. W.!
Salicornia australis, *Forst.* Banks and Sol.!

Paronychieæ.

Scleranthus biflorus, Banks and Sol.!

Polygoneæ.

Polygonum minus, *var.* decipiens. W. L. W.!
" aviculare, *L.*
Muhlenbeckia adpressa, *Lab.* Banks and Sol.!
" complexa, *Meisn.* Banks and Sol.!
" axillaris, *Hook. f.* W. L. W.!
" ephedroides, *Hook. f.* Rangitaiki: W. L. W.! The extreme northern limit of the last two species.
Rumex flexuosus, *Forst.* Banks and Sol.!

Laurineæ.

Litsea calicaris, *Benth. and Hook. f.* Hicks Bay and East Cape: W. L. W.! The southern limit on the east coast.
Beilschmiedia tawa, *Benth. and Hook. f.*
" tarairi, *Benth. and Hook. f.* Raukokore: W. L. W. The extreme southern limit of the tarairi.

Monimiaceæ.

Laurus novæ-zelandiæ, *A. Cunn.* W. L. W.
Hedycarya dentata, *Forst.* Banks and Sol.!

Proteaceæ.

Knightia excelsa, *R. Br.* Banks and Sol.!
Persoonia toro, *A. Cunn.* Between Whangaparaoa and Hicks Bay: W. L. W.!

Thymeleæ.

Pimelea longifolia, *Banks and Sol.* Banks and Sol.!
" virgata, *Vahl.* W. L. W.!
" buxifolia, *Hook. f.* Mount Hikurangi: S. Dodgshun!
" arenaria, *A. Cunn.* Banks and Sol.!
" urvilleana, *A. Rich.* Banks and Sol.! I have not seen specimens.
" lævigata, *Gaertn.* T. K.

Loranthaceæ.

Loranthus colensoi, *Hook. f.* Waikaremoana: Colenso. The extreme northern habitat.
Loranthus tetrapetalus, *Forst.* Colenso: Excursion, p. 38.
" decussatus, *T. Kirk.*
" micranthus, *Hook. f.* W. L. W.!
Tupeia antarctica, *Cham. and Schl.*

EUPHORBIACEÆ.

Euphorbia glauca, *Forst.* Banks and Sol. !

CUPULIFERÆ.

Fagus menziesii, *Hook. f.*
  „ fusca, *Hook. f.* !
  „ solandri, *Hook. f.* !
  „ cliffortioides, *Hook. f.*
    The two last attain their extreme northern limit near the East Cape and Cape Runaway.

URTICEÆ.

Paratrophis heterophylla, *Blume.* W. L. W. !
  „ „ *var.* elliptica. Tolago: Banks and Sol. ! Waipara: W. L. W. !
Urtica incisa, *Poiret.* Banks and Sol. !
  „ ferox, *Forst.* W. L. W. !
Parietaria debilis, *Forst.* Banks and Sol. !

PIPERACEÆ.

Peperomia endlicheri, *Miq. !* Banks and Sol.
Peperomia reflexa, *A. Dietrich.* Between Waiomatatini and Te Araroa: H. Hill !
Peperomia muricatulata, *Col. !* Between Waiomatatini and Te Araroa: H. Hill !
Piper excelsum, *Forst.* Banks and Sol. !

BALANOPHOREÆ.

Dactylanthus taylori, *Hook. f.* Te Araroa: H. Hill !

CONIFERÆ.

Libocedrus doniana, *Endl.* W. L. W.
Podocarpus ferruginea, *Don.*
  „ nivalis, *Hook. f.* Mount Hikurangi: S. Dodgshun !
  „ totara, *A. Cunn.*
  „ spicata, *R. Br.*
  „ dacrydioides, *A. Rich.*
Dacrydium cupressinum, *Sol.*
Phyllocladus trichomanoides, *Don.* W. L. W.
  „ alpinus, *Hook. f.* W. L. W.

ORCHIDEÆ.

Earina mucronata, *Lindl.* W. L. W.
  „ suaveolens, *Lindl.*
Dendrobium cunninghamii, *Lindl.*
Bulbophyllum pygmæum, *Lindl.* W. L. W. !
  „ tuberculatum, *Col.* L. Wall !
Sarcochilus adversus, *Hook. f.* J. B. Lee !
Acianthus sinclairii, *Hook. f.* J. B. Lee !
Adenochilus gracilis, *Hook. f.* Colenso.

Corysanthes triloba, *Hook. f.* W. L. W!
Microtis porrifolia, *Spreng.* Banks and Sol.!
Pterostylis banksii, *R. Br.* Banks and Sol.!
„ trullifolia, *Hook. f.* J. B. Lee!
Thelymitra longifolia, *Forst.*
„ colensoi, *Hook. f.* Tolago: H. B. Kirk! A single imperfect specimen only.

IRIDEÆ.

Libertia ixioides, *Spreng.* W. L W.!
„ grandiflora, *Sweet.* Banks and Sol.!
„ pulchella, *Spreng.* W. L W.!

PANDANEÆ.

Freycinetia banksii, *A Cunn* Banks and Sol.!

TYPHACEÆ.

Typha angustifolia, *L.* W. L W.
Sparganium angustifolium, *R Br.* Near Waikaremoana: A. Hamilton!

NAIADEÆ.

Lemna minor, *L.*
„ gibba, *L.* Poverty Bay: Colenso.
Triglochin striatum, *Ruiz. and Pav.*
Potamogeton natans, *L.* W. L W.
„ cheesemanii, *A. Benn.*
Zannichellia palustris, *L.* Colenso.

LILIACEÆ.

Rhipogonum scandens, *Forst.* Banks and Sol.!
Enargea marginata, *F. Muell.* Waikaremoana.
Cordyline australis, *Hook. f.*
„ banksii, *Hook. f.*
„ indivisa, *Kunth.* W. L. W.
„ pumilio, *Hook f.* Banks and Sol.!
Dianella intermedia, *Endl.*
Astelia cunninghamii, *Hook. f.* Banks and Sol.!
„ microsperma, *Col.* H. Hill!
Arthropodium cirrhatum, *R. Br.* Banks and Sol.!
„ candidum, *Raoul.* Colenso.
Phormium tenax, *Forst.* Banks and Sol.!
„ cookianum, *Le Jolis.* Banks and Sol.

PALMEÆ.

Rhopalostylis sapida, *Wendl. and Drude.* Banks and Sol.!

JUNCEÆ.

Juncus maritimus, *Lam.* T. K.
„ communis, *E. Meyer.*
„ planifolius, *R. Br.* Banks and Sol.!
„ *sp.* Waipara: W. L. W.

Juncus pauciflorus, *R. Br.* Banks and Sol. !
„ bufonius, *L.*
Luzula campestris, *DC.* Banks and Sol. !

RESTIACEÆ.

Leptocarpus simplex, *A. Rich.* Banks and Sol. !

CYPERACEÆ.

Cyperus ustulatus, *A. Rich.* Banks and Sol. !
Schœnus axillaris, *Hook f.*
„ tendo, *Banks and Sol.* Banks and Sol. !
Scirpus maritimus, *L.*
„ lacustris, *L.* W. L. W. !
„ pungens, *Vahl.* Banks and Sol. !
„ frondosus, *Banks and Sol.* !
„ nodosus, *Rottb.*
„ antarcticus, *L. f.* Banks and Sol. !
Eleocharis sphacelata, *R. Br.* Near Waikaremoana: A. Hamilton !
Eleocharis acuta, *R. Br.* Banks and Sol. !
„ cunninghamii, *Boeckl.* Banks and Sol.
Cladium gunnii, *Hook. f.* Banks and Sol. !
„ sinclairii, *Hook f.* Banks and Sol. !
Gahnia gaudichaudii, *Steud.* Banks and Sol. !
„ hectori, *T. Kirk.*
„ xanthocarpa, *Hook. f.*
„ lacera, *Steudel.* W. L. W. !
Lepidosperma tetragona, *Labill.* Banks and Sol. !
Uncinia australis, *Pers.*
„ *var.* ferruginea.
Carex virgata, *Sol.*
„ tornaria, *Forst.* Banks and Sol. !
„ testacea, *Sol.* Banks and Sol. !
„ lucida, *Boott.* Banks and Sol. !
„ pumila, *Thunb.* W. L. W. !
„ comans, *Bergg.* W. L. W. !
„ solandri, *Boott.* J. B. Lee !
„ dissita, *Sol.* Banks and Sol. !
„ pseudocyperus, *L., var.* fascicularis. Banks and Sol. !

GRAMINEÆ.

Microlæna stipoides, *R. Br.* W. L. W. !
„ avenacea, *Hook. f.*
Alopecurus geniculatus, *L.* W. L. W. !
Hierochloe redolens, *R. Br.* Banks and Sol. !
Spinifex hirsutus, *Labill.* Banks and Sol. !
Paspalum scrobiculatum, *L.* W. L. W. !
Oplismenus undulatifolius, *Beauv.* Banks and Sol. !
Zoysia pungens, *Willd.* W. L. W. !

Echinopogon ovatus, *Pal.* Banks and Sol. !
Dichelachne crinita, *Hook. f.* Banks and Sol. !
Stipa arundinacea, *Benth. and Hook. f.* W. L. W.
Sporobolus indicus, *R. Br.* W. L. W. ! Introduced.
Deyeuxia forsteri, *Kunth.* W. L. W. !
„ pilosa, *Buch.* Banks and Sol. !
„ billardieri, *Kunth.* Banks and Sol. !
„ avenoides, *Buch.* Waiapu : W. L. W. !
„ quadriseta, *Benth.* W. L. W. !
Arundo conspicua, *Forst.* Banks and Sol. !
„ fulvida, *Buch.* Banks and Sol. !
Danthonia cunninghamii, *Hook. f.* Banks and Sol. !
„ semiannularis, *R. Br.*
Trisetum antarcticum, *Trin.* Banks and Sol. !
Glyceria stricta, *Hook. f.* W. L. W. !
Poa anceps, *Forst.*
Schedonorus littoralis, *Beauv.* Banks and Sol. !
Agropyron multiflorum, *Beauv.*

Filices.

Gleichenia circinata, *Swartz.*
Cyathea dealbata, *Swartz.*
„ medullaris, *Swartz.*
Hemitelia smithii, *Hook.* Banks and Sol. !
Alsophila colensoi, *Hook. f.* Runanga : W. L. W. !
Dicksonia squarrosa, *Swartz.* Banks and Sol. !
„ fibrosa, *Col.* W. L. W. !
„ lanata, *Col.* W. L. W. !
Hymenophyllum tunbridgense, *Sm.*
„ bivalve, *Swartz.* W. L. W. !
„ multifidum, *Swartz.*
„ rarum, *R. Br.* W. L. W. !
„ pulcherrimum, *Col.* Waikaremoana.
„ dilatatum, *Swartz.*
„ polyanthos, *Swartz.*
„ demissum, *Swartz.* Banks and Sol.
„ scabrum, *A. Rich.* W. L. W. !
„ flabellatum, *A. Rich.* W. L. W. !
„ æruginosum, *Carm.* W. L. W. !
Trichomanes reniforme, *Forst.*
„ humile, *Forst.*
„ venosum, *R. Br.* W. L. W. !
„ elongatum, *A. Cunn.* J. B. Lee !
Davallia novæ-zelandiæ, *Col.* W. L. W. !
Lindsaya viridis, *Col.* W. L. W. !
Adiantum hispidulum, *Swartz.* W. L. W. !
„ diaphanum, *Blume.* Banks and Sol. !
„ affine, *Willd.*

Hypolepis tenuifolia, *Bernh.*
„ millefolium, *Hook.* W. L. W. !
„ distans, *Hook.* W. L W. !
Cheilanthes tenuifolia, *Swartz.* W. L. W.
Pellæa rotundifolia, *Hook.* Banks and Sol. !
Pteris aquilina, *L.*, *var* esculenta. Banks and Sol. !
„ tremula, *R Br.* Banks and Sol. !
„ scaberula, *A. Rich.*
„ incisa, *Thunb* W. L W.
„ macilenta, *A. Rich.* Banks and Sol. !
Lomaria filiformis, *A Cunn.* Banks and Sol. !
„ capensis, *Willd.* Banks and Sol. !
„ fluviatilis, *Spreng.*
„ membranacea, *Col.*
„ vulcanica, *Blume.* W. L. W. !
„ patersoni, *Spreng.* W. L. W. !
„ lanceolata, *Spreng.* Banks and Sol. !
„ discolor, *Willd.*
„ alpina, *Spreng.* W. L. W.
Doodia media, *R. Br.* Banks and Sol. !
Asplenium obtusatum, *Forst.* Banks and Sol. !
„ falcatum, *Laun.* Banks and Sol. !
„ hookerianum, *Col.*
„ bulbiferum, *Forst.*
„ flaccidum, *Forst.* Banks and Sol.
„ umbrosum, *J. Sm* Opotiki, Whakatane. W. L. W.!
Aspidium aculeatum, *Swartz*, *var.* vestitum
„ richardi, *Hook.* Banks and Sol !
„ capense, *Willd.*
Nephrodium thelypteris, *Desv.*, *var.* squamulosum. W. L. W. !
„ decompositum, *R. Br.* W. L. W. !
„ glabellum, *A. Cunn.*
„ velutinum, *Hook. f.* W. L. W. !
„ hispidum, *Hook.* Banks and Sol. !
Polypodium rugulosum, *Lab.* W. L. W.
„ pennigerum, *Forst.* Banks and Sol. !
„ australe, *Mett.*
„ grammitidis, *R. Br.*
„ tenellum, *Forst.* Banks and Sol. !
„ serpens, *Forst.*
„ cunninghamii, *Hook.*
„ scandens, *Forst.* Banks and Sol. !
„ pustulatum, *Forst.*
„ novæ-zelandiæ, *Baker.* Near Waikaremoana: A. Hamilton !
Gymnogramme leptophylla, *Desv.* W. L. W.
Todea hymenophylloides, *Rich. and Less.*
„ superba, *Col.* W. L. W. !

Schizæa bifida, *Swartz*. W. L. W.
Botrychium ternatum, *Swartz*. W. L. W.

LYCOPODIACEÆ.

Lycopodium billardieri, *Spring*. Banks and Sol. !
 " " *var*. varium. W. L. W.
 " densum, *R. Br.* W. L. W.
 " fastigiatum, *R. Br.* W. L W. !
 " scariosum, *Forst.* W. L. W !
 " volubile, *Forst.*
Tmesipteris tannensis, *Forst.*
Isoetes, *sp.* "In deep water in the bed of the Motu, between Opotiki and Cape Runaway, but I was unable to obtain specimens on account of the depth of the water." *H. B. Kirk.*

MARSILEACEÆ.

Azolla rubra, *R. Br.* Poverty Bay, &c.: W. L. W !

ART. XLIX.—*On the History of Botany in Otago.*

By T. KIRK, F.L.S.

[*Read before the Wellington Philosophical Society, 17th February, 1897.*]

THE publication of Mr. Petrie's copious and valuable "List of the Flowering-plants indigenous to Otago" in the last volume of "Transactions of the New Zealand Institute" naturally attracts attention to the efforts of earlier labourers in the same field, so that no apology is needed for presenting a brief statement of the results of their efforts. The elaboration of the flora or fauna of any district can only be effected by a long succession of earnest workers, those of the present taking up the work where it fell from the hands of their predecessors, and in their turn passing it on to those who succeed them. It is well that the memory of the pioneers in any branch of research should be treasured by those who reap the benefit of their labours.

The first botanists to visit any part of Otago were Reinwold and George Forster, and Dr. Sparrman, who accompanied Cook's second expedition, and landed at Dusky Sound in 1772. Their collections were not large, comprising fewer than 170 species, including those obtained in Queen Charlotte Sound, &c. Most of these were published in G. Forster's "Florulæ Insularum Australium Prodromus," but the descriptions were very poor. Amongst the plants obtained by them were the famous *Cordyline indivisa* and the true *Gentiana saxosa.*

Dr. Archibald Menzies, surgeon to Captain Vancouver's expedition, collected largely at Dusky Sound in 1791, especially in Ferns, Musci and Hepaticæ. Many beautiful species collected by him were described by Sir William Hooker in his "Musci Exotici," and in Hooker and Greville's "Icones Filicum." *Gentiana saxosa* was also collected by Menzies, but was not seen by other collectors until it was found by Professor Hutton at the Bluff in 1873.

Dr. Lyall, surgeon on H.M.S. "Acheron," during Captain Stokes's survey of the South Island, 1847–49, made large collections of plants in Stewart Island, Foveaux Strait, and the west coast of Otago, including many important additions to the flora, the most striking being the grand *Ranunculus lyalli* (found in a flowerless state only) and *Senecio bifistulosus*. These and others were described by Sir Joseph Hooker in "Flora Novæ-Zelandiæ."

In 1861 Dr. W. Lauder Lindsay visited Otago, spending rather less than three months in the district, during which he made excursions to Taieri Ferry, Clutha Ferry, Tuapeka, Wetherstone's Diggings, and other places within sixty miles of Dunedin, and proved himself a most indefatigable collector and acute observer. Long known an an able lichenologist, he exhibited a decided preference for lichens and other cryptogams, of which he made extensive collections, but was scarcely less enthusiastic in his investigation of the flowering-plants of the district, adding *Celmisia lindsayi* and *Poa lindsayi* to the flora. *Viscum lindsayi*, named in his honour by Professor Oliver, was originally discovered by Mr. Buchanan. The results of his work were published in 1868, under the title of "Contributions to New Zealand Botany," with several coloured illustrations by Fitch. He gives a catalogue of the plants collected during his excursions, showing 199 species of flowering-plants, 40 ferns, &c., 149 lichens, 110 diatoms, with numerous mosses, algæ, and fungi, making a total of 610 species, of which 50 were supposed to be undescribed. The work abounds with critical notes, which are always interesting, and often of high value, the whole constituting an almost unique contribution to the botanical literature of the colony.

In 1862–63 Sir James Hector and Mr. Buchanan explored large portions of the West Coast sounds and mountains, and succeeded in making numerous important additions to the flora, most of which were described in the "Handbook of the New Zealand Flora" by Sir Joseph Hooker, 1864–67. In addition to the discovery of new species, they greatly extended our knowledge of indigenous plants. Amongst the most remarkable of their discoveries were *Pachycladon novæ-zelandiæ*, *Ranunculus buchanani*, *R. chordorhizos*, *R. pachyrrhizus*, *Hectorella cæspitosa*, &c.

Mr. Buchanan had previously done good botanical work in various parts of the district. Some of his additions were described in the Handbook, while others, such as *Colobanthus buchanani*, *C. canaliculatus*, &c., have but recently received the attention they merit. In 1865 he prepared his "Sketch of the Botany of Otago," with a catalogue of the flowering-plants and ferns collected in the district to that date. This was not published until 1869, when it appeared in the Appendix to the first volume of "Transactions of the New Zealand Institute," greatly increasing the value of the volume. In the Sketch he divided the provincial district into an eastern and a western region, the dividing-line extending along the course of the Clutha from Lake Wanaka to the Nuggets. He enumerates 600 species, of which 393 are dicotyledons, 118 monocotyledons, the remainder ferns and fern allies. When the difficulties under which the author had to labour at that time are considered, and the fact that the concluding portion of the Handbook had not been published is taken into account, it will be seen that its accuracy is remarkable. In this respect it has not been excelled by any later production of a similar character. Until his removal to Wellington Mr. Buchanan held the office of botanist and draughtsman to the Geological Survey of Otago. Numerous papers on Otago plants, with illustrations from his facile pencil, are scattered through the annual volumes of "Transactions of the New Zealand Institute." It should be added that his "Sketch of the Botany of Otago" was the first local flora published in the colony.

In 1872 Mr. J. S. Webb published a short list of plants found in the vicinity of Invercargill in the fifth volume of the "Transactions of the New Zealand Institute," which comprised three or four species not previously recorded for the Otago district.

Mr. G. M. Thomson published a copious list of interesting plants not previously recorded for the Otago district in the "Transactions of the New Zealand Institute," vol. ix., p. 538. Amongst them are several species of considerable interest—*Melicytus macrophyllus*, a northern plant, the occurrence of which in Otago could not have been anticipated; *Senecio sciadophilus*; and *Myrsine chathamica*. A catalogue of the naturalised plants of the district, by the same author, appeared in vol. vii., p. 370, of the Transactions.

Under the title of "Contributions to the Botany of Otago," a list of about a hundred flowering-plants and ferns not previously recorded for the district was published by the present writer in the tenth volume of the Transactions. The list comprised *Carmichaelia monroi*, *Drosera pygmæa*, only known elsewhere in the colony at its northern extremity, *Celmisia*

walkeri, *Gratiola nana*, *Potamogeton pectinatus*, *Carex acicularis*, *Stipa arundinacea*, &c.

In 1880 Mr. G. M. Thomson and Mr. Petrie visited Stewart Island. The latter gentleman published an interesting account of the trip, with a valuable list of the flowering-plants collected, in vol. xiii., p. 323, of the Transactions. *Liparophyllum gunnii*, *Actinotus bellidioides*, *Ehrharta thomsoni*, and *Carex longiculmis* were amongst the interesting additions recorded.

Dr. Lyall had collected numerous plants on the island during his visit in the "Acheron." Mr. G. M. Thomson had visited it on two previous occasions, when he discovered the fine *Brachycome*, named in his honour; and the late Mr. Charles Traill had collected for several years previously, but, with the exception of Dr. Lyall's plants which are included in the "Handbook," nothing had been published.

Mr. Petrie's "List of the Flowering-plants indigenous to Otago," published in the "Transactions of the New Zealand Institute," vol. xxviii., page 540, is the last and the most important contribution to the botany of the southern district, and embodies the results of nearly twenty years' work. Mr. Petrie is a close and acute observer, who made good use of the advantages offered by his position as Chief Inspector of Schools to the Education Board of Otago in working up the central portions of the district, the botany of which was but little known. The results of his examination of Mount St. Bathan's, Mount Pisa, Mount Ida, Mount Cardrona, and other high peaks constitute a marked feature in the botanical history of New Zealand during recent years, and have from time to time been published in the Transactions.

In his List he roughly divides the district into three—eastern, central, and western, Stewart Island making a fourth; but the district lists are not so complete as their author evidently intended to make them; for instance, in his paper on Stewart Island (Trans., xiii., 323) he enumerated two hundred species of flowering-plants collected by him on that island; but the number of Stewart Island plants mentioned in the general list is considerably less. This, however, is, after all, a small matter, and will only be felt by one who, like myself, finds it continually necessary to refer to local lists. I am thankful to have so complete and accurate a catalogue available for reference. Mr. Buchanan's list comprised 507 species of flowering-plants, of which 393 were dicotyledons, and 114 monocotyledons. Mr. Petrie enumerates 532 dicotyledons and 229 monocotyledons, showing an increase of fully 50 per cent. in the number of species, and greatly reducing the enormous discrepancy between the two classes, as shown by Mr. Buchanan's list.

Although not so expressed, Mr. Petrie's list is evidently restricted to plants collected by himself. He gives as an appendix a separate list of plants reported to occur in Otago, but not observed by him. This might have been considerably extended.

In the hope of rendering this Otago Florula still more comprehensive, I venture to add a few species not included in Mr. Petrie's enumeration, and append a short list of plants which have been erroneously recorded by various authors as indigenous to the Otago district. In conclusion, I am glad to acknowledge my indebtedness for the assistance derived from Mr. Petrie's work during the preparation of the "Student's Flora," now in the press.

Species either wholly omitted from Mr. Petrie's List or mentioned with a very restricted Range of Distribution.

Clematis hexasepala, *DC.* Bluff Harbour: *T. K.*

Ranunculus traversii, *Hook. f.* In a deep valley near Lake Harris; below Mount Earnslaw: *T. K.*

Ranunculus enysii, *T. Kirk.* East Taieri Hills: *J. Buchanan!*

Ranunculus recens, *T. Kirk.* Otago: *Buchanan!*

Melicytus macrophyllus, *A. Cunn.* Waikari Creek: *G. M. Thomson!*

Pittosporum rigidum, *Hook. f.* Dusky Sound: *Hector and Buchanan!*

Colobanthus quitensis, *Bart.* Otago: *Buchanan!*

Colobanthus canaliculatus, *T. Kirk.* Otago: *Buchanan!*

Colobanthus buchanani, *T. Kirk.* Otago: *Buchanan!*

Colobanthus brevisepalus, *T. Kirk.* Gorge Creek and Kurow: *Petrie!*

Elæocarpus dentatus, *Vahl.* Catlin's River: *T. Kirk.*

Carmichaelia grandiflora, *Hook. f.* Milford Sound: *Lyall.*

Drosera pygmæa, *DC.* The Bluff Hill: *T. K.*

Gunnera mixta, *T. Kirk.* *Buchanan! Hamilton! Petrie!*

Gunnera flavida, *Colenso.* The most common species in Southland: *T. K.*

Gunnera pro-repens. Ryal Bush: *T. Waugh!*

Gunnera hamiltonii. New River Heads: *W. S. Hamilton!* Stewart Island.

Gunnera microcarpa, *T. Kirk.* Near Invercargill, &c.: *T. Waugh!*

Gunnera arenaria, *Cheesem. var.* Sandy Point, &c.: *T. Waugh!*

Callitriche muelleri, *F. Sond.* Stewart Island: *T. K.*

Epilobium tasmanicum, *Haussk.* Mountains above Lake Harris, 3,000ft.: *T. K.*

Epilobium purpuratum, *Hook. f.* Alps of Otago, 6,000ft.: *Buchanan !*

Epilobium novæ-zelandiæ, *Haussk.* Eweburn Creek and Naseby: *Petrie !*

Epilobium vernicosum, *Cheesem.* Clinton Valley, Te Anau: *Petrie !*

Epilobium pycnostachyum, *Haussk.* Otago lake district: *Buchanan !*

Epilobium polyclonum, *Haussk.* Otago: *Buchanan; Petrie !*

Tetragonia expansa, *Murr.* Dog Island: *T. K.*

Actinotus novæ-zelandiae, *Petrie.* Longwood Range: *T. K.* Doubtless not unfrequent on the West Coast mountains.

Aciphylla lyallii, *Hook. f.* Dusky Bay: *Lyall; Buchanan !*

Ligusticum lyallii, *Hook. f.* Port Preservation: *Lyall !*

Ligusticum flabellatum, *T. Kirk.* Stewart Island.

Panax lineare, *Hook. f.* Mountains above Lake Harris: *T. K.* Frequent in the West Coast Sounds: *Hector !*

Aralia lyallii, *T. Kirk.* Coal Island, Preservation Inlet; Ruapuke and other islands in Foveaux Strait; southern portion of Stewart Island; common. Extinct in Paterson Inlet.

Griselinia lucida, *Forst.* Catlin's River: *Lindsay.* Martin's Bay, Dusky Sound: *T. K.*

Corokia cotoneaster, *Raoul.* Otago: *Buchanan !*

Olearia traillii, *T. Kirk:* Puysegur Point. Stewart Island: *T. K.*

Olearia nitida, *var.* cordatifolia. Perhaps the most handsome form of this variable species. Bluff Hill. Stewart Island: *T. K.*

Olearia oleifolia, *T. Kirk.* Resolution Island: *J. D. Enys !*

Olearia nummularifolia, *Hook. f.* Otago Lake District: *Hector and Buchanan !* Maungatua: *B. C. Aston !*

Olearia forsteri, *Hook. f.* Near Oamaru: *R. Kidd !*

Celmisia lindsayi, *Hook. f.* The reputed Lake Harris station for this fine plant is very doubtful indeed, the plant being purely littoral. In "crevices of the trap rocks at the Nuggets," the specimens are small, sometimes not more than 3in.–4in. high, but on the tops of the cliffs at the back of the pilot's house, Catlin's River, it forms huge masses 6ft.–8ft. in diameter or more, with the branches stout and woody at the base. Probably common on the north side of Foveaux Strait. One of the most beautiful species of the genus.

Abrotanella muscosa, *T. Kirk.* Summit of Rakiahua, Stewart Island: *T. K.*

Abrotanella linearis, *Bergg.* Port Pegasus: *T. K.*

Cotula traillii, *T. Kirk.* Stewart Island: *T. K.*

Senecio bifistulosus, *Hook. f.* Dusky Sound: *Lyall; Buchanan !* Also in Chalky Bay (identified in the absence of flowers).

Lobelia anceps, *Thunb.* Oamaru: *R. Kidd!*
Gaultheria perplexa, *T. Kirk*, MS. Bluff Hill, &c.; Stewart Island: *T. Kirk.*
Cyathodes pumila, *Hook. f.* Otago: *Buchanan!* Maungaatua: *B. C. Aston!*
Archeria traversii, *var.* australis. West Coast Sounds; Mount Anglem, Stewart Island: *T. K.*
Dracophyllum strictum, *Hook. f.* West Coast Sounds. Common.
Myrsine pendula, *Col.* Stewart Island: *T. K.*
Mitrasacme novæ-zelandiæ, *Hook. f.* Dusky Sound; *Buchanan.* Stewart Island: *T. K.*
Gentiana lineata, *T. Kirk.* Crest of the Longwood Range: *T. K.*
Liparophyllum gunnii, *Hook. f.* Crest of the Longwood Range.
Sebæa ovata, *R. Br.* Otago: *Buchanan!*
Exarrhena lyallii, *Hook. f.* Milford Sound: *Lyall.*
Convolvulus sepium, *L.* Near Winton: *T. K.* Herekopere Island: *T. K.*
Dichondra radicans, *MSS.* Stewart Island.
Limosella aquatica, *L.* The typical form, with broad oblong-lanceolate or spathulate leaves. Near Kingston: *T. K.* The only locality in which it has at present been seen. Mr Petrie sends a plant with cleistogamous flowers which may belong to another species
Limosella curdeyana, *F. Muell.* Owake; plentiful: *T. K.* (1875).
Veronica parviflora, *Vahl.* Otago: *Buchanan.*
Veronica ligustrifolia, *A. Cunn.* Otago and Stewart Island: *Lyall; Buchanan.*
Veronica hillii, *Colenso.* Otago: *Buchanan* (1867).
Veronica buchanani, *Hook. f.* Lake district: *Buchanan!* Mount Kyeburn; Mount Arnold; Oteinata River: *Petrie!* 3,000ft.–4,000ft.
Veronica tetragona, *Hook.* Greenstone Valley: *Buchanan* (1867).
Veronica uniflora, *T. Kirk.* Hector's Col, Mount Aspiring; 5,000ft.: *Buchanan!*
Veronica quadrifaria, *T. Kirk.* Mount Alta; 5,000ft.: *Buchanan!*
Veronica tumida, *T. Kirk.* Otago: *Buchanan!*
Veronica gilliesiana, *T. Kirk.* Mountains of the west coast: *Buchanan!*
Veronica dasyphylla, *T. Kirk* (Logania tetragona, *Hook. f.*). Mountains of the west coast: *Buchanan!*
Veronica erecta, *T. Kirk.* Mount Bonpland (?): *Mr. Martin!*
Veronica muelleri, *Buch.* Hector's Col, Mount Aspiring Range; 5,000ft.: *Buchanan!*

Euphrasia repens, *Hook. f.* Bluff Island: *Lyall.* Oreti River, *T. K.* Port Pegasus, *T. K.*

Utricularia monanthos, *Hook. f.* Stewart Island. Doubtless the *U. colensoi* of Mr. Petrie's list, due to a clerical error.

Teucridium parviflorum, *Hook. f.* Water of Leith, near Dunedin: *T. K.*

Pimelea virgata, *Vahl.* By the ascent to the Crown Range, Cardrona, and elsewhere: *T. K.*

Fagus blairii, *T. Kirk.* Head of Lake Wakatipu. Valley of the Dart, &c.: *T. K.*

Ascarina lucida, *Hook. f.* Preservation Inlet; plentiful: *T. K.* Stewart Island; rare: *C. Traill!*

Urtica australis, *Hook. f.* Dog Island: *T. K.*

Dacrydium intermedium, *T. Kirk.* West Coast Sounds; common on Stewart Island: *T. K.*

Dacrydium westlandicum, *T. Kirk.* Martin's Bay.

Lemna minor, *L.* Near Invercargill and elsewhere: *T. K.*

Potamogeton pectinatus, *L.* Waihola Lake: *T. K.* (1876).

Potamogeton oblongifolius, *Schrad.* Near Invercargill: *J. S. Webb!*

Cordyline indivisa, *Steud.* Dusky Sound: *Forster; Buchanan.* Milford Sound: *T. K.*

Juncus antarcticus, *Hook. f.* Swamp near Lind's Crossing, Southland: *T. K.* Mount Anglem, Stewart Island: *T. K.*

Juncus scheuzerioides, *Gaudich.* Lake district: *Hector and Buchanan!*

Centrolepis strigosa, *Roem. and Schult.* Bluff Hill: *T. K.*

Scirpus fluitans, *L.* Bluff Harbour: *T. K.*

Uncinia nervosa, *Boott.* By the Routeburn: *T. K.* Port Pegasus, Stewart Island: *T. K.*

Carex australis, *T. Kirk.* Stewart Island: *T. K.*

Carex solandri, *Boott.* Near Dunedin, &c.; Stewart Island: *T. K.*

Ehrharta thomsoni, *Petrie.* Crest of the Longwood Range: *T. K.* Probably common on the West Coast mountains.

Simplicia laxa, *T. Kirk.* Waikouaiti and Deep Stream: *Petrie!*

Agrostis scabra, *Willd.* (*A. parviflora*, R. Br., Hook. f., Fl. N.Z., i., 296). Abundant in the Lake district and elsewhere: *Hector and Buchanan.* Certainly indigenous: *T. K.*

Agrostis spencei, *T. Kirk*, MSS. Sea-cliffs, Te Waewae Bay.

Arundo fulvida, *Buch.* Mataura: *Buchanan!*

Poa foliosa, *Hook. f.* The typical plant, not found on the mainland. Herekopere Island: *T. K.*

Poa walkeri, *T. Kirk*, MSS. Riverton, in salt marshes; Stewart Island: *T. K.*

Poa anceps, *Forst.* Stewart Island: *Petrie*, "List of Stewart Island Plants." Rakiahua; rare: *T. K.*

Plants erroneously recorded by Various Authors as having been collected in the Otago District.

Ranunculus areolatus, *Petrie*.—Scraps of the Scandinavian *R. pygmæus*, Wahl. (mixed with fragments of *R. rivularis*, Banks and Sol.), said to have been collected at Lake Wakatipu, were given to Mr. Petrie, who described them under this name.

Carmichaelia australis, *R. Br.*—Not found south of the Marlborough district.

Carmichaelia odorata, *Col.* Some other species must have been mistaken for this.

Metrosideros scandens, *Banks and Sol.*—Included in Buchanan's list, but has not been seen in Otago of late years, although reported from the Auckland Islands.

Azorella reniformis, *Benth. and Hook. f.*—I am indebted to Mr. Petrie for specimens of the Otago plant so named by him, which must be referred to *A. haastii*, Hook. f. The stipules of the Otago plant are ciliate, while those of *A. reniformis* are acute, and quite entire; the fruits of *A. haastii* are usually shorter than the pedicels, while those of *A. reniformis* usually exceed the pedicels I fell into exactly the same mistake with a form of *A. haastii* from the Spencer Mountains.

Ligusticum acutifolium, *T. Kirk*.—This has only been found on the Snares, which are outside the district.

Pseudopanax lessonii, *C. Koch*.—Buchanan's specimen, named *Panax lessonii* in the "Herbarium of the Otago Museum," is a narrow-leafed form of *Panax colensoi*, Hook. f.

Veronica carnea, *J. B. Armst.*—A garden plant of unknown origin, certainly not indigenous in New Zealand.

Pimelea urvilleana, *A. Rich.*—Probably a clerical error.

Libocedrus doniana, *Endlich.*—Evidently a slip of the pen for *L. bidwillii*, Hook. *f.*

Potamogeton heterophyllus, *Schreb.*—The name occurs in Lindsay's list, the young state of *P. cheesemanii* having been mistaken for it.

Carex neesiana, *Endlich.*—Has not been found in New Zealand, *C. solandri* being usually mistaken for it.

Stipa teretifolia, *Steudel.* (*Dichelachne stipoides*, Hook. f.).—Doubtless a clerical error, as the plant is not found south of Poverty Bay.

IV.—GEOLOGY.

Art. L.—*The Moas of the North Island of New Zealand.*

By Captain F. W. Hutton, F.R.S., Curator of the Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1896.*]

Plates XLVII. and XLVIII.

The moas of the North Island are not so well known as those of the South Island. This is partly owing to the scarcity of their remains, and partly because they were the first described. Sir R. Owen gave specific names to the bones as they were sent to him, and was obliged to fit them together by guesswork. Thus the leg-bones of his *D. gracilis*, *D. dromæoides*, and *D. curtus* belong, in each case, to two distinct species, while *D. didiformis* and *D. geranoides* are made up from the bones of three different species. Both Mr. R. Lydekker and I have tried to correct these mistakes, and the differences in our nomenclature arose almost entirely from our having pursued different systems with Owen's composite species. I took the metatarsus of each as the type of the species, while Mr. Lydekker took the bone which had been described first, no matter what it might be. Although my plan was the simpler of the two, that of Mr. Lydekker was more in conformance with the rule of priority, and, as his publication is so much better known than mine, I have now conformed to his rule, for all we want to get is a permanent and generally-recognised nomenclature. Mr. Lydekker also resuscitated Sir R. Owen's old name of *Dinornis novæ-zealandiæ* and applied it to all the large individuals from the North Island, remarking that "specimens belonging to more than one species were included under this name. As the first-mentioned specimen is a femur which is not absolutely characteristic, it seems best to take the second tibia [of *D. ingens*] as the type."* But the femur first mentioned has a

* "Catalogue of the Fossil Birds in the British Museum," p. 224.

length of 11in., and a circumference at the middle of 5½in., which measurements are certainly characteristic of the femur of *D. struthioides*; indeed, this very bone is referred by Mr. Lydekker to *D. struthioides* on p. 245, No. 18597, of his catalogue. If, therefore, the name is to be used at all it should be given to the smaller, not the larger, individuals of *Dinornis* in the North Island. But Owen employed the name only in his provisional notes, and before his paper was published he broke up his former species into three, and dropped the first-proposed name altogether. There is therefore no description of *D. novæ-zealandiæ*, and by the rules of zoological nomenclature the name should be abandoned. At any rate, I think that this is a case in which later authors may respect the wishes of the giver of a name without doing any harm to science.

During the last four years I have been able to examine at leisure the collection of North Island bones in the Canterbury Museum, and I have also visited the Museums at Auckland, Wanganui, Wellington, and Dunedin as opportunities offered, and have to thank Mr. T. F. Cheeseman, Mr. S. H. Drew, Sir James Hector, Professor T. J. Parker, and Mr. Augustus Hamilton for the facilities they offered me for examining their collections of moa-bones. I have thus been enabled to correct several mistakes, and to clear up most of the obscure points; but we cannot expect to have the nomenclature quite fixed until the skulls and sterna of several species have been found and correctly determined.

With regard to the number of species of *Dinornis*, the material does not exist to work them out in the same way as I did those of Kapua,* I have therefore taken the three South Island species as a guide in limiting the North Island species, and, consequently, I have reduced two names of my own making to the rank of synonyms. For my reasons for using the generic term *Euryapteryx* instead of *Emeus*† I must refer the reader to my paper on the axial skeleton of the *Dinornithidæ* in Trans. N.Z. Inst., vol. xxvii, p. 158. No doubt it is difficult to decide what should be considered as a sufficient description and what is not sufficient, but I think it will be allowed that when a naturalist makes a new genus he should at least have seen the specimen he names, and that he should point out one, at least, generic character. If this is allowed Reichenbach's names will not stand. No doubt Sir Julius von Haast made mistakes, as all his successors have done; but he correctly conceived his three genera—*Meionornis*, *Eury-*

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* Trans. N.Z. Inst., vol. xxviii., p. 627.

† There is an *Emea*, Leidy (1848), among the Vermes, which is too near *Emeus*.

apteryx, and *Palapteryx*—and gave *M. casuarinus*, *E. gravis*, and *P. elephantopus* as their types. *Palapteryx* cannot be allowed in Haast's sense, for it had already been used differently, but the other two should, in my opinion, be retained. *Anomalopteryx* must also be changed, as it is preoccupied in insects, and, consequently, I propose to substitute *Anomalornis* for it.

Formerly it was thought that the genera *Pachyornis* and *Euryapteryx* were confined to the South Island, while several species of *Dinornis*, *Meionornis*, and *Anomalornis* were common to both islands. But it now appears that most of the genera occur in both islands, while nearly all the species of each island are distinct. There is as yet no proof that *Meionornis* lived in the North Island, and no skull or sternum of *Pachyornis* or of *Megalapteryx* have been found in the North and none of *Cela* in the South Island. Also, the three species *Megalapteryx tenuipes*, *Cela curta*, and *Pachyornis pygmæus*, are only provisionally considered as belonging to both islands, the first and third being very imperfectly known, and the evidence for the occurence of *C. curta* in the South Island resting solely on a single metatarsus in the British Museum, said to come from near Oamaru.

The general conclusion to be drawn from this is that the two islands of New Zealand were separated from each other after the development of most of the genera, but before the development of the known species,* and that they have not since been united. It also follows that the deposits of moa-bones at Te Aute, Glenmark, Kapua, Enfield, Waikouaiti, Hamilton's, &c., are of a later date than the separation of the islands.

Dinornis giganteus.

Dinornis giganteus, Owen, Trans. Zool. Soc., iii., p. 244 (1844). *Dinornis novæ-zealandiæ*, ♀, Lydekker, Cat. Fossil Birds in B.M., p. 224. *Dinornis giganteus* and *excelsus*, Hutton, Trans. N.Z. Inst., xxiv., pp. 110 and 112.

Figures.—Metatarsus, Trans. Z.S., iii. (and Ext. Birds of N.Z.), pl. 27, fig. 1; tibia, *l.c.*, iii., pl. 45 (Ext. Birds, pl. 37), fig. 1; femur, *l.c.*, iii., pl. 44 (Ext. Birds, p. 36).

This species appears to have been rare, as it is known at present by a few leg-bones only. There is no femur nor complete tibia in the Canterbury Museum. The type is a metatarsus 468mm. in length. The tibia described by Owen has a length of 887mm., and a distal width of 101mm. The femur, which was found with the tibia, has a length of 406mm. A metatarsus and a tibia were found together near

* Except, of course, *Anomalornis antiquus*.

Auckland, the lengths of which were 451mm. and 800mm. respectively. A very large tibia, found at Te Aute, was measured by the Rev. W. Colenso, and said to have a length of 954mm., and a distal width of 96mm. Two metatarsi in the Canterbury Museum, one from Te Aute the other from Wanganui, have the following measurements: Length, 514mm.; prox. width, 104mm.; mid. width, 51mm.; distal width, 140mm. These bones are more slender than those of *D. maximus*, and the extremities of the metatarsus and tibia are not so expanded.

A pre-maxilla, belonging to this species or the next, from near Wanganui, is more pointed and more curved down at the apex than the same bone in *D. maximus* or *D. robustus*. It resembles the pre-maxilla of *D. torosus*, but is much larger. The following are its dimensions: Length, 113mm.; length of body, 60mm.; width of body, 57mm.

I have already, in my papers on the moas of Kapua and Enfield,* explained why I cannot agree with Mr. Lydekker that this species is the female of the next.

Dinornis ingens.

Dinornis ingens, Owen, Trans. Zool. Soc., iii., p. 247 (1844). *Dinornis novæ-zealandiæ*, ♂ Lydekker, Cat. Foss. Birds in B.M., p. 227. *Dinornis firmus* and *ingens*, Hutton, Trans. N.Z. Inst., xxiv., pp. 114 and 116.

Figures.—Metatarsus, Trans. Z.S., iii., pl. 48 (Ext. Birds, pl. 40), fig. 1; tibia, *l.c.* (and Ext. Birds), pls. 25 and 26, figs. 1, 2; femur, *l.c.* (and Ext. Birds), pl. 21, figs. 1, 2; cranium,† *l.c.*, iv., pls. 2, 3, and 24 (Ext. Birds, 52 and 53), figs. 1, 3.

The type is a tibia 736mm. in length, and with a distal width of 92mm. The Rev. W. Colenso has in his possession the bones of an individual leg the lengths of which are: Metatarsus, 412mm.; tibia, 736mm.; femur, 368mm. The commonest lengths are: Metatarsus, 355mm., and tibia, 660mm. The largest metatarsus in the Canterbury Museum has the following dimensions: Length, 419mm.; prox. width, 96mm.; mid. width, 48mm.; distal width, 132mm. The smallest metatarsus is: Length, 343mm.; prox. width, 77mm.; mid. width, 38mm.; distal width, 38mm. A tibia has the following dimensions: Length, 645mm.; prox. width, 142mm.; mid. width, 45mm.; distal width, 86mm. The largest femur is: Length, 366mm.; prox. width, 124mm.; mid. width, 55mm.;

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* Trans. N.Z. Inst., vol. xxviii., pp. 627 and 645.

† The skull, figured as that of *D. ingens*, in Trans. Zool. Soc., vii., pl. 15, and Extinct Birds, pl. 82, is very incorrect, and should be disregarded.

distal width, 147mm. The smallest femur is: Length, 325mm.; prox. width, 117mm.; mid. width, 45mm.; distal width, 132mm.

This species was far more common than the last; but, like it, it is distinguished from its allies in the South Island by greater slenderness of limb. Mr. Lydekker gives also the greater obliquity of the extensor bridge of the tibia as a character by which the North Island species can be recognised from those of the South Island, but I cannot follow him in this.

Dinornis struthioides.

Dinornis novæ-zealandiæ (part), Owen, Pro. Zool. Soc., 1843, p. 8 (no description). *Dinornis struthioides*, Owen, Trans. Zool. Soc., iii., p. 244 (1844). *Dinornis dromioides*, Owen, *l.c.*, iii., p. 319 (1846), tibia and metatarsus. *Dinornis struthioides*, Owen, *l.c.*, iv., p. 141 (1853). *Dinornis gracilis*, Owen, *l.c.*, iv., p. 145 (1853), tibia and metatarsus. *Dinornis struthioides* and *gracilis*, Lydekker, Cat. Fossil Birds in Brit. Mus., pp. 242 and 248 (1891). *Dinornis struthioides*, *gracilis*, and *Palapteryx dromioides*, Hutton, Trans. N.Z. Inst., xxiv., pp. 119–121 (1892).

Figures.—Metatarsus, Trans. Zool. Soc., iii. (and Extinct Birds), pl. 27, fig. 2; pl. 48 (E.B., pl. 40), fig. 2 (*dromioides*); iv., pl. 41 (E.B., pl. 54), figs. 3, 4 (*gracilis*): tibia, *l.c.*, iii., pl. 47 (E.B., pl. 39), fig. 1 (*dromioides*); *l.c.* iv., pl. 42 (E.B., pl. 55), figs. 1, 2 (*gracilis*): femur, *l.c.*, iii. (E.B.), pl. 21, fig. 3; iv., pl. 41 (E.B., pl. 54), fig. 2: cranium, *l.c.*, iii., pl. 38 (E.B., pl. 16), figs. 1–4.

This species varies very much in size, and possibly two may be included. The type is a metatarsus 279mm. in length. There is an almost perfect skeleton in the collection of Sir Walter Buller, and an imperfect one in the British Museum. In the Wellington Museum there are the bones of a leg, found together, which have the following lengths: Metatarsus, 302mm.; tibia, 559mm., femur, 286mm.

The following are the dimensions of the largest and smallest bones in the Canterbury Museum:—

—	Length.	Prox Width.	Mid. Width.	Distal Width.
Metatarsus ..	294mm.	79mm.	35mm.	101mm.
	246mm.	61mm.	25mm.	76mm.
Tibia	483mm.	134mm.	40mm.	71mm.
	464mm.	91mm.	30mm.	58mm.
Femur	312mm.	106mm.	43mm.	124mm.
	218mm.	72mm.	30mm.	70mm.(?)

There is a pelvis in the Wellington Museum, from Waipawa, which has the length of the ilium 470mm., length of pre-acetabular portion 223mm., and breadth at the anti-trochanters 203mm. In Mr. A. Hamilton's collection, from Te Aute, there is a much smaller pelvis, in which these measurements are 305mm., 140mm., and 152mm. respectively. In the Canterbury Museum there is an imperfect cranium and pre-maxilla, from Wanganui, which is 60mm. wide at the temporal fossæ, while the distance between the temporal ridges is 44mm. The pre-maxilla belonging to this skull is 78mm. in length; the length of the body is 46mm., and its width 47mm.

D. struthioides is smaller and more slender than *D. torosus*, and the extremities of the leg-bones are not so dilated. It has been found from Whangarei in the north to Wanganui in the south.

Megalapteryx tenuipes.

Megalapteryx tenuipes, Lydekker, Cat. Fossil Birds in Brit. Mus., p. 251 (1891). *Megalapteryx tenuipes*, Hutton, Trans. N.Z. Inst., vol. xxviii., p. 635 (1896).

There are in the British Museum two femora from the North Island which Mr. Lydekker refers to this or an allied species. One has a length of 255mm., while the other is slightly smaller and relatively narrower, especially at the distal extremity. The latter comes from Waingongoro, near Wanganui.

There are no bones of *Megalapteryx* from the North Island in the Canterbury Museum, and I have not seen any in any other museum.

Anomalornis* gracilis.

Plate XLVII., Fig. A.

(?) *Dinornis didiformis*, Owen, Trans. Z.S., iii., p. 245 (1844), tibia. *Dinornis gracilis*, Owen, *l.c*, iv., p. 143 (1853), femur. *Anomalopteryx*, sp. *a*, Lydekker, Cat. Fossil Birds in Brit. Mus., p. 255.

Figures.—(?) Tibia, Trans. Zool. Soc., iii. (and E.B.), pls. 25, 26, figs. 3, 4 (*didiformis*); femur, *l.c.*, iv., pl. 41 (E.B., pl. 54), fig. 1.

The type of this species is a femur from Opito, near Mercury Bay, which has a length of 278mm., a proximal width of 95mm., a mid. width of 38mm., and a distal width of 101mm. There is in the Canterbury Museum a femur, from Akitio, which closely resembles the type, but is smaller. With it I provisionally associate a tibia and metatarsus (Plate XLVII.,

* Substituted for *Anomalopteryx*, as that name is preoccupied (1874) in the *Neuroptera*.

fig. A) of *Anomalornis* found in a cave at Waipu, north of Auckland. The dimensions of these three bones are as follows:—

—	Length.	Prox Width.	Mid. Width.	Distal Width.
Metatarsus	203mm.	66mm.	36mm.	91mm.
Tibia	419mm.	117mm.	36mm.	55mm.
Femur	257mm.	? mm.	32mm.	80mm.

No doubt the femur belonging to the leg from the Waipu Cave would be larger, as its mid. width would be about 36mm. The tibia is specifically identical with that figured by Owen, in 1844, as belonging to *D. didiformis*, but as that name goes with the metatarsus, which belongs to a smaller species, we fall back on the femur as giving the name. Mr. Lydekker is of opinion that the tibia figured by Owen may belong to *A. dromæoides*, but I think it is too large. No doubt it belongs to one or other of these species.

There is in the Canterbury Museum a pelvis from Pohui, Hawke's Bay, presented by Mr. H. Hill, F.G.S., which I am inclined to refer to this species. It is a typical *Anomalornis* in shape, and has the following dimensions: Length of the ilium, 355mm.; length of pre-acetabular portion, 198mm; height of pre-acetabular portion of ilium, 83mm.; width at the antitrochanters, 160mm. The lower margin of the posterior portion of the ilium descends as a sharp ridge. The lower surfaces of the centra of the three pre-sacral vertebræ are hollowed longitudinally.

Anomalornis didiformis.

Dinornis didiformis, Owen, Trans. Zool. Soc., iii., p. 242 (1844), metatarsus. *Anomalopteryx didiformis** (part), Lydekker, Cat. Foss. Birds in B.M., p. 276 (1891). *Anomalopteryx didiformis* (part), Hutton, Trans. N.Z. Inst., xxiv., p. 123 (1892).

Figures.—Metatarsus, Trans. Zool. Soc., iii. (and E.B), pl. 27, figs. 3–6: (?)pelvis, *l.c.* (and E.B.), pl. 19, fig. 3; pl. 20, fig. 4: cranium, *l.c.*, iii., pl. 39 (E.B., pl. 31), figs. 4–6 (*dromæoides*).

The type is a metatarsus from Poverty Bay, which (from the figure) has the following dimensions: Length: 173 mm.; prox. width, 55mm.; mid. width, 31mm.; distal width, 76mm. In the Canterbury Museum there is a set of the three bones of the leg from a cave near Whangarei, the

* Not *Meionornis didiformis*, Haast, which is *M. didinus*.

metatarsus of which corresponds closely with Owen's figure and description. The following are their dimensions:—

—		Length	Prox. Width.	Mid. Width.	Distal Width
Metatarsus	..	167mm.	57mm.	30mm.	71mm.
Tibia ..	..	335mm.	94mm.	30mm.	49mm.
Femur ..	..	230mm.	76mm.	30mm.	74mm.

I have no doubt that these three bones belonged to the same individual. There is in the Museum collection a pair of femora from Akitio, east coast of Wellington, which have the following dimensions: Length, 228mm.; prox. width, 76mm.; mid. width, 33mm.

There is in the Auckland Museum a cranium, and another in the Canterbury Museum, from the same cave near Whangarei, and it is probable that one or other of them belongs to the leg-bones in the Canterbury Museum. They closely resemble the skull of *A. parvus*, but are flatter, and the temporal ridges do not extend so far over the roof of the cranium. The best-preserved one has the optic foramina closer together than in *A. parvus*, and there is no horizontal shelf of bone below them, and no pre-sphenoidal fossa. Also the three foramina of the lacerate fossa are all united, and communicate with the optic foramen. The following are the only dimensions which can be taken: Width at squamosals, 65mm.; width at temporal fossæ, 42mm.; distance between temporal ridges, 34mm.; height of cranium, 41mm.; distance between optic foramina, 7mm. The other cranium is of about the same size, but more imperfect. So far as can be seen, it differs from it only in the absence of a mid-temporal ridge, which is probably due to age or sex.

The pelvis described by Owen (as p. 5, Trans. Zool. Soc., iii., p. 256) probably belongs here, as also does another in Mr. A. Hamilton's collection from Te Aute, which measures 318mm. in length, with a width of 146mm. at the antitrochanters. These differ from the pelvis of *A. parvus* in having the lower surfaces of the centra of the sacral vertebræ longitudinally ridged, as in *Meionornis*. Another pelvis, from the Hawke's Bay district, presented by Mr. H. Hill, F.G.S., has the following dimensions: Length of the ilium, about 300mm.; of pre-acetabular portion, 152mm.; height of pre-acetabular portion of ilium, 76mm.; width at the antitrochanters, 140mm. This pelvis differs from the typical pelvis in *Anomalornis parvus* in having the lower margin of the posterior portion of the ilium flattened out, as in *Euryapteryx*. But that it is an

Anomalornis is shown by the compressed centrum of the anterior vertebra, and by its anterior pneumatic foramina not descending below the rib-facet. The lower surfaces of the centra of the three pre-sacral vertebræ are hollowed longitudinally, as in the last species.

Anomalornis oweni.

Dinornis oweni, Haast, Trans. Zool. Soc., xii., p. 171 (1886). *Anomalopteryx oweni*, Lydekker, Cat Fossil Birds in Brit. Mus., p 280 (1891). *Cela curta* (part), Hutton, Trans. N.Z. Inst., xxiv., p. 127 (1892).

Figures.—Limb-bones, skull, and two vertebræ, Trans. Zool. Soc., xii., pl. 31; pelvis, Trans Zool. Soc., xii., pl 32.

The type skeleton is in the Auckland Museum

The following are the measurements of the largest and smallest of the leg-bones in the Canterbury Museum—the smallest are rather larger than the types :—

—	Length.	Prox Width.	Mid Width	Distal Width
Metatarsus ..	128mm. 117mm.	44mm. 40mm	24mm. 21mm.	58mm. 49mm.
Tibia	285mm 259mm.	75mm 70mm.	23mm. 20mm	39mm 36mm.
Femur	157mm. 150mm.	50mm. 50mm.	23mm. 21mm.	52mm. 49mm.

The femur has not the characters of the typical *Anomalornis*, but is short and straight, with a rather deep popliteal depression. The tibia has the distal extremity much expanded inwards, as in *A. parvus*. The metatarsus has deep lateral pits on the middle trochlea, and generally on the anterior surface at its base.

The skull is very like that of *A. didiformis*, but is rather smaller. The lacerate fossa is distinct from the optic foramen, and there appears to have been a pre-sphenoidal shelf below the optic foramen; but this part of the skull is much damaged. The width at the squamosals is 62mm.; width at the temporal fossæ, 42mm.; and the distance between the temporal ridges is 29mm. The height of the cranium is 33mm. Distance between optic foramina, 6mm.; length of body of pre-maxilla, 20mm.; width of the same, 18mm.; greatest height of the mandible, 14mm.; length of mandibular symphysis, 6mm.; width of the same, 8mm.

The width of the pelvis at the antitrochanters is (from the figure) 102mm. The whole of the posterior portion is absent,

but, judging from the figure, the centra of the ribless sacral vertebræ have their lower surfaces rounded, and with a rudimentary longitudinal keel. The sternum is not known.

Cela* curta.

Plate XLVII., Fig. B.

Dinornis curtus, Owen, Trans. Zool. Soc., iii., p. 325 (1846). *Anomalopteryx curta*, Lydekker, Cat. Fossil Birds in Brit. Mus., p. 281. *Cela curta*, Hutton, Trans. N.Z. Inst., xxiv., p. 127.

Figures.—Metatarsus, Trans. Zool. Soc., iii., pl. 48 (E.B., pl. 40), fig. 6; vii., pl. 44 (E.B., pl. 87), figs. 7–10: tibia, *l.c.*, iii., pl. 47 (E.B., pl. 39), figs. 3–5: femur, *l.c.*, v., pl. 55 (E.B., pl. 68), figs. 5, 6 (*geranoides*): cranium, *l.c.*, iv., pl. 24 (E.B., pl. 53), fig. 5; xiii., pls. 61, 62, *Mesopteryx*, sp. *a.*

This was a common species all over the North Island. The metatarsus figured by Owen in "Extinct Birds of New Zealand," pl. 87, f. 7, is from a cave fourteen miles distant from Oamaru. All other bones are from the North Island. The type is a tibia from Waingongoro, near Wanganui, which has a length of about 292mm.

The following are the dimensions of the largest and smallest leg-bones in the Canterbury Museum:—

—	Length.	Prox. Width.	Mid Width.	Distal Width.
Metatarsus	138mm.	46mm.	26mm.	58mm.
	127mm.	41mm.	24mm.	54mm.
Tibia	310mm.	81mm.	25mm.	41mm.
	294mm.	76mm.	24mm.	41mm.
Femur	170mm.	64mm.	26mm.	?
	162mm.	56mm.	25mm.	55mm.

The pelvis is like that of *Meionornis casuarinus*, but much smaller, and the centra of the sacral vertebræ are compressed. The length of the ilium is 203mm.–228mm.; that of the pre-acetabular portion is 94mm.–107mm. The height of the ilium before the acetabulum is 63mm.–70mm.; and the width at the antitrochanters is 120mm.–127mm.

The sternum resembles that of *M. casuarinus*, but there are no pneumatic depressions in the antero-lateral corners. The width below the costal border is about 68mm.

I refer to this species the skull described by Professor

* As *Cela* of Möhring is a synonym of *Casuarius*, the name may perhaps be allowed to stand here.

T. J. Parker, F.R.S., under the name of *Mesopteryx*, sp. n., from Te Aute (Plate XLVII., fig. B). This skull resembles that of *Meionornis casuarinus* in—(1) Its arched cranial roof; (2) the shape of the temporal fossæ and ridges; (3) the uniformly-rounded orbits; (4) the small mammillar tuberosities; and (5) the slender-pointed mandible. But it differs in (6) the supra-foraminal ridge not projecting beyond the occipital condyle; (7) in the par-occipital processes being short and rounded; (8) in the margin of the tympanic cavity being evenly curved; (9) in the zygomatic processes sloping more forward and outward; (10) in the broader posterior temporal fossæ; (11) in the presence of a sulcus immediately in front of the ridge separating the temporal fossa from the optic cavity; (12) in the pre-sphenoidal fossa extending considerably in advance of the optic foramen; and (13) in the broad articular cup and small posterior angular process of the mandible.

In all these points the skull approaches those of *Anomalornis* or *Pachyornis*, especially the latter. There is another specimen of what appears to be the same or a closely related species in the Auckland Museum, from a cave near Whangarei. It is more imperfect than the one from Te Aute, and has no mandible. The two skulls are alike in size, and in the shape of the par-occipital processes, the tympanic cavity, the zygomatic processes, and the posterior temporal fossæ, and also in the shape of the temporal fossæ and presence of a sulcus in front of the ridge separating the temporal fossa from the optic cavity. The pre-sphenoidal fossa cannot be compared.

However, the Whangarei specimen differs from that from Te Aute in many small particulars. The occipital condyle does not project so much, and is overhung by the supra-occipital ridge, as in *Meionornis*. The cranial roof is more convex, both longitudinally and transversely; the mammillar tuberosities are better developed; the area between the temporal and lambdoidal ridges is rather narrower; the post-orbital processes are broader; the optic foramina are larger and rounder; and the three foramina of the lacerate fossa are larger. This cranium has the basi-pterygoid processes preserved; they are very slender, and project downward more than in any other species. No doubt the two skulls belong to the same genus.

The dimensions of the Te Aute skull are given by Professor Parker. The following are those of the Whangarei skull: Length of basis cranii, 26mm.; length of roof of cranium, 65mm.; width at squamosals, 51mm.; at temporal fossæ, 41mm.; at postorbital processes, 62mm.; distance between

* Trans. Zool. Soc. of London, vol. xiii., p. 378.

the temporal ridges, 36mm.; height of the skull, 38mm.; distance between optic foramina, 7mm. It is, I have no doubt, specifically identical with that figured by Owen in "Extinct Birds of New Zealand," pl. 53, fig. 5.

The Whangarei skull is nearer to *Meionornis* than is that from Te Aute; but the curved margin of the tympanic cavity and the sulcus close to the posterior margin of the optic cavity are found in both, but never occur in *Meionornis*. If to these we add the large pre-sphenoidal fossa and the shape of the articular cup of the mandible, seen in the Te Aute specimen, we have sufficient reasons for placing these skulls in a different genus from *Meionornis*, or, at any rate, in a distinct sub-genus of *Meionornis*. The mandible is quite unique among the moas, combining the slender rami of *Meionornis* with the broad articular cup of *Anomalornis* and *Pachyornis*. The photograph (Plate XLVII., fig. B) shows the articular cup well, but the point of the beak looks more rounded than it really is, owing to distortion by pressure when wet. The differences between the vertebræ of *Cela* and *Meionornis* have been pointed out by me in the Trans. N.Z. Inst., vol. xxvii., p. 166.

There is in the Museum collection a femur from Tolago Bay, which shows the pneumatic foramen very plainly.

Euryapteryx exilis, sp. nov.

Plate XLVIII., Fig. C.

Figures.—Femur, Trans. Zool. Soc., iii. (and E.B.), pl. 24, figs. 1–3 (*didiformis*): pelvis, *l.c.* iii. (and E.B.), pl. 19, fig. 2 (*didiformis*); pl. 20, figs. 2, 3 (*didiformis*).

The type of this species is a nearly-complete skeleton in the Wanganui Museum. It appears to have been common in the southern parts of the North Island, but its bones have been confounded partly with those of *A. didiformis* and partly with those of *C. curta*. Indeed, the slimness of the legs would have prevented them being put into the genus *Euryapteryx* if they had not been accompanied by the skull.

The following are the dimensions of the leg-bones of the type specimen:—

—	Length.	Prox. Width.	Mid. Width.	Distal Width.
Metatarsus	140mm.	55mm.	30mm.	63mm.
Tibia	338mm.	101mm.	28mm.	44mm.
Femur	210mm.	72mm.	30mm.	74mm.

But the species evidently attained a larger size, for there are in the Canterbury Museum bones belonging to this species of the following sizes:—

—	Length.	Prox. Width.	Mid Width	Distal Width.
Metatarsus	155mm.	54mm.	32mm.	68mm.
Tibia	368mm.	100mm.	32mm.	53mm.
Femur	213mm.	76mm.	33mm.	81mm.

This metatarsus and femur are from Wanganui; the tibia from Akitio, on the east coast of Wellington Province.

The bones resemble those of *E. crassa*, but the tibia is more convex on the anterior surface.

The skull (Plate XLVIII., fig C) resembles that of *E. crassa* in miniature, but with some differences The occipital condyle does not project beyond the par-occipital processes. The plane of the occipital foramen is inclined backwards. The occipital crest, the lambdoidal and posterior lambdoidal ridges, the supra-foraminal ridges, and the par-occipital processes are like those of *E. crassa*. The cranial roof is much vaulted, evenly arched from side to side, and with only a slight frontal rising, such as is conspicuous in other species of *Euryapteryx*. Also, the flat area between the temporal and lambdoidal ridges is narrower than in other species. The margin of the orbit is evenly curved. The basi-occipital is shorter than in *E. crassa*, and the mammillar tuberosities are but slightly developed; the basi-pterygoid processes are broad.

The rostrum, maxillo-jugal arch, palatines, and pterygoids are missing.

The tympanic cavity is as in *E. crassa*, and the zygomatic process is bifid. The posterior temporal fossa is narrow, as it is in all species of *Euryapteryx*. The temporal fossæ are relatively broader than in *E. crassa*, and are shaped as in *Meionornis*, but they resemble those of *Emeus*, sp. β, in Professor Parker's memoir "On the Cranial Osteology of the Dinornithidæ."* The optic foramina are large and wide apart for the genus. The supra-orbital ledge makes almost a right angle with the inner portion of the orbital roof, instead of gradually sloping into it, as is usual. The quadrate is like that of *E. crassa*, but the orbital process is more slender.

The pre-maxilla is short and broad; the apex has been abraded, but, judging from the shape of the mandible, it was no doubt rounded. The mandible is much deflexed, broadly U-shaped at the apex—more so than in *E. crassa*—and the symphysis is broad and low. The articulating-cup of the ramus is like that of *E. crassa*, but the external posterior angular process is not so prominent. The following are the measurements in the order of Professor Parker's paper, already

* Trans. Zool. Soc. of London, vol. xiii., p. 373.

quoted: Length of skull, 92mm (?); length of basis cranii, 27mm.; length of roof of cranium, 64mm; width at paroccipital processes, 46mm.; width at squamosals, 51mm.; width at temporal fossæ, 40mm.; width at post-orbitals, 62mm.; distance between temporal ridges, 35mm.; height of cranium, 38mm; width of tympanic cavity, 17mm.; width of temporal fossa, 19mm, width of orbit, 24mm.; distance between optic foramina, 10mm; greatest length of pre-maxilla, 57mm (?); length of body, 16mm (?); width of body, 27mm.; length of mandibular ramus, 85mm.; greatest height of mandible, 14mm.; least height of mandible, 8mm.; length of mandibular symphysis, 10mm (?); width of mandibular symphysis, 26mm.

The skull undoubtedly belongs to *Euryapteryx;* but in the shape of the temporal fossæ, in the small mammillar tuberosities, and in the small posterior angular processes of the mandible it approaches the skull of *Cela.* On the other hand, the distance between the optic foramina and the narrowness of the flat area between the temporal and lambdoidal ridges are characters which connect it with *Anomalornis.*

The cervical vertebræ have neural ridges as in *Meionornis;* the atlas and axis are missing. The thoracic vertebræ resemble those of other species of *Euryapteryx*, but there are only two pairs of sternal ribs, which belong to vertebræ Nos. 24 and 25. No. 28 is anchylosed to the pelvis, showing that the bird is an old one. There are seventy tracheal rings preserved with the skeleton, and about twenty more were found, but were too brittle to be moved. The upper rings are of the slender elliptical pattern, while the lower ones are of the thick, rough, tube-like pattern, one pattern passing into the other about half-way down.

The sternum agrees with that of other species of *Euryapteryx*, but there are slight saucer-shaped coracoidal depressions. The costal processes are large and horizontal. The following are its dimensions: Length of body, 83mm.; total length, 152mm.; width of body, 100mm.; width across costal processes, 152mm.

The pelvis resembles that of other species of *Euryapteryx.* The centre of the ilium is slightly in front of the centre of the acetabulum. The length of the pre-acetabular portion of the ilium is 127mm. (?), and its depth is 76mm. The width at the antitrochanters is 165mm.

Pachyornis rothschildi.

Pachyornis rothschildi, Lydekker, Pro. Zool. Soc., 1891, p. 279.

Figures.—Leg-bones, P.Z.S., 1891, pl. 38.

Described from a set of leg-bones supposed to belong to the same individual; locality not known, but thought by Mr.

Lydekker to be from the North Island. The following dimensions are given :—

—	Length (about)	Mid Width	Distal Width
Metatarsus	216mm.	53mm.	127mm
Tibia	559mm	..	75mm
Femur	269mm	..	124mm

No other part of the skeleton is known The shafts of the tibiæ are very much curved, but this may be an individual deformity

There are in the Christchurch Museum some leg-bones from Te Aute, which I refer to this species They have the following dimensions .—

—	Length	Prox Width	Mid Width	Distal Width
Metatarsus ..	176mm.	76mm	46mm	99mm
Tibia	483mm	110mm	41mm.	71mm
Femur	259mm.	100mm	46mm	112mm

Although these bones are smaller than the types and the metatarsal trochleæ are not so expanded, still they have the same relatively long tibia which distinguishes this species from *P. inhabilis*, but they are not curved like the type. Other bones, rather larger than these, were also found at Te Aute, and are now in the collection of Mr. A. Hamilton.

Pachyornis pygmæus.

Plate XLVIII, Fig. D.

Dinornis geranoides, Owen, Trans. Zool. Soc., v., p 395 (1866). *Anomalopteryx(?) geranoides*, Lydekker, Cat. Fossil Birds in Brit. Mus., p 288 (1891). *Cela geranoides*, Hutton, Trans. N.Z. Inst, xxiv., p. 126 (1892). *Euryapteryx pygmæus*, Hutton, Trans. N.Z Inst, xxiv., p. 139 (1892).

Figures.—Metatarsus, Trans. Zool. Soc., v., pl. 67 (E. B, pl. 70), figs. 5, 6; femur, Trans. N.Z. Inst., xxvii., pl. 9.

A very rare species, the type of which is a metatarsus found near Nelson. There is also in the British Museum a metatarsus from a cave near Oamaru; all other known specimens are from the North Island. These are more slender than the type, and may perhaps belong to a distinct species. A metatarsus from Wanganui, in the Canterbury Museum, has the following dimensions: Length, 152mm.; proximal

width, 59mm ; mid. width, 32mm.; and distal width, 76mm. I have not seen a tibia which I can refer to this species. Mr. Lydekker gives the average length at 342mm., and distal width 55mm. There are three femora in our collection, all from Te Aute. The largest is: Length, 221mm.; prox. width, 82mm.; mid. width, 38mm.; distal width, 84mm. The smallest is: Length, 201mm.; prox. width, 75mm.; mid. width, 34mm.; distal width, 72mm. There is also a small pelvis from Te Aute which has the characteristics of *Pachyornis*, and which, therefore, I refer to this species (Plate XLVIII., fig. D). The middle of the ilium is situated at the posterior margin of the acetabulum; the pre-acetabular ridge, formed by the ilia, is straight axially; the posterior portion of the ilium is very broad and flat; the ventral surfaces of the centra of the sacral vertebræ are strongly curved transversely, but are not so narrow as in *P. elephantopus*. The following are its dimensions: Length of ilium, 305mm.; length of the pre-acetabular portion of the ilium, 127mm., and its depth, 76mm.; width at the antitrochanters, 159mm.

Incertæ sedis.

Dinornis dromæoides, Owen, Trans. Zool. Soc., iii., p. 250, pl. 22, figs. 1, 2 (1844). *Anomalopteryx dromæoides*, Lydekker, *l.c.*, p. 266.

Professor C. Stewart has been kind enough to send me a cast of the type femur of this species, which is preserved in the museum of the Royal College of Surgeons. This specimen, which is slightly abraded at the proximal end, has the following dimensions: Length, 235mm.; proximal width, 84mm.; mid. width, 35mm.; distal width, 84mm. There is in the Canterbury Museum collection a femur from Te Aute which has the same size and shape, but in which the popliteal depression is deeper. These femora are not those of a true *Anomalornis*, but might belong to a species of *Cela* or *Meionornis*. It is just possible that the tibia and metatarsus, here included provisionally as *A. gracilis*, may belong to *D. dromæoides*, but they have the characters of *Anomalornis* and not those of *Meionornis*. There is in the Auckland Museum a very imperfect pelvis, which may also belong to *D. dromæoides*; its width at the antitrochanters is 184mm.

Palapteryx geranoides, Owen, Trans. Zool. Soc., iii., p. 361 (1848), pl. 54 (E.B., pl. 45), figs. 1–7. *Anomalopteryx*(?) *geranoides*, Lydekker, *l.c.*, p. 290.

This species is founded on a skull, and is therefore not comparable with the others, which are founded on leg-bones. Mr. Lydekker proposes to take either the metatarsus or the tibia described by Owen under the same name—*Pachyornis*

pygmæus of this paper—as the type, but this is against the rule followed in other cases, and cannot, I think, be allowed. He also places the cranium only in his *A. geranoides*, stating that the pre-maxilla and mandible belong to *M. casuarinus*. But Owen's figures do not bear this out, for both pre-maxilla and mandible are represented as belonging to *Anomalornis*, and are not at all like the same bones in *M. casuarinus*; and as no other bones of *M. casuarinus* have been found in the North Island, I hesitate to accept Mr. Lydekker's determination. The cranium and the mandible resemble a good deal those which I attribute to *A. fortis*; but the North Island cranium is flatter, and has larger temporal fossæ. I therefore think that Owen was right in placing these bones together, but that in his restoration he has made the mandible too long. Probably this skull belongs to *D. dromæoides* or to *A. gracilis*, but we must await some lucky discovery before this can be proved.

EXPLANATION OF PLATES XLVII. and XLVIII.

PLATE XLVII.

Fig. A. Metatarsus of *Anomalornis gracilis*, from a cave at Waipu.

Fig. B. Cranium and mandible of *Cela curta*, from the swamp at Te Aute. The mandible is distorted by pressure when wet; the apex is really as pointed as in *M. didinus*.

PLATE XLVIII.

Fig. C. Skull of *Euryapteryx exilis*, from the sandhills near Wanganui.

Fig. D. Pelvis of *Pachyornis pygmæus*, from the swamp at Te Aute.

ART. LI.—*On the Leg-bones of* Meionornis *from Glenmark.*

By Captain F. W. HUTTON, F.R.S., Curator of the Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 6th May, 1896*.]

No deposit of moa-bones has as yet been found when draining the swamps on the Canterbury Plains. They only occur among the low hills surrounding the plains, and of these by far the most important was that at Glenmark. The earlier finds here were in 1866 and 1867, and some account of the bones is given by Sir Julius von Haast in the first volume of the "Transactions of the New Zealand Institute." But a still larger find was made in 1872, of which there is no record.

The bones were found chiefly in an old swamp, covered by from 4ft. to 12ft., or even more, of peat. They were accompanied by bones of *Harpagornis*, *Aptornis*, and *Cnemiornis*, *Apteryx australis* and *A. oweni*, *Ocydromus* (sp.), and *Sphenodon punctatus*. Dr. Von Haast also mentions bones of *Nestor* and of *Anas finschii*, but they are not now in the Museum. In his description of the locality he points out that the alluvial river-beds are older than the swamp deposit, but that there is no difference in the species of moas found in each. He says, "All the different species, as it were, have appeared together, and have afterwards become extinct about the same time."*

The Glenmark collections have been dispersed over nearly the whole world, and it is impossible now to arrive at any accurate results as to the relative numbers and measurements of the different species found there; but there are still in the Museum 126 metatarsi, 131 tibiæ, and 116 femora of *Meionornis*, collected in the swamp, and these are sufficient to give a correct idea of the sizes of the species of this genus. With this object in view, I have measured all these bones, and tabulated them in the same way as I did those from Kapua and Enfield, and arrive at the following results:—

Meionornis casuarinus.

This species is smaller and more slender than at Kapua or Enfield, the average length of the metatarsus being 210mm. (8·25in.); of the tibia, 463mm. (18·25in.); and of the femur, 263mm. (10·5in.). It is the "No. 3, *D. casuarinus*, smallest size," of Dr. Von Haast's paper in the first volume of the "Transactions of the New Zealand Institute." The accompanying diagram gives the two principal measurements of all the leg-bones, and shows that there is only a single point of concentration in each. Consequently there is no evidence of three distinct sizes, as supposed by Dr. Von Haast. *M. casuarinus* appears to have been at Glenmark nearly four times as common as *M. didinus*. The following are the numbers of the bones: Metatarsi, about 97; tibiæ, 104; femora, about 90.

Meionornis didinus.

This species is about the same size as at Kapua and Enfield, but it is not so well marked off from *M. casuarinus*; indeed, no line can be drawn dividing either the metatarsi or the femora of the two species. It is only the tibiæ which are distinctly separated, and even with this bone the point of concentration is on the side nearest to *M. casuarinus*. It is "No. 4, *D. didiformis*, largest size," of Dr. Von Haast's paper already referred to. The following are the numbers of the bones: Metatarsi, about 31; tibiæ, 27; femora, about 26.

* "Geology of Canterbury and Westland," Christchurch, 1879, p. 448.

Length of the metatarsus, 184mm. (7 25in.); of the tibia, 393mm. (15 5in.); and of the femur, 254mm (10in.)

GENERAL REMARKS.

The differences thus shown to exist between the birds from Glenmark and those from Kapua and Enfield are probably due to differences in the age of the deposits Geological considerations would favour the idea that the Enfield deposit was the youngest of the three, as the bones were close to the surface, while the fact that *M. casuarinus* and *M. didinus* are less differentiated from each other at Glenmark than at the other places may be taken as palæontological evidence that it is the oldest; and, arranging the deposits in this order, we have the average dimensions of the leg-bones of the two species as follow —

MEIONORNIS CASUARINUS.

—	Metatarsus				Tibia				Femur			
	Length	Prox Width	Mid Width	Distal Width	Length	Prox Width	Mid Width	Distal Width	Length	Prox Width	Mid Width	Distal Width
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm.
Enfield ..	215	81	46	96	490	134	44	71	286	106	43	120
Kapua ..	216	76	46	102	483	140	46	66	279	102	43	119
Glenmark ..	210	64	43	07	463	123	40	64	263	99	38	99

MEIONORNIS DIDINUS.

—	Metatarsus.				Tibia				Femur			
	Length	Prox. Width.	Mid Width.	Distal Width.	Length.	Prox. Width	Mid Width	Distal Width.	Length	Prox. Width	Mid Width	Distal Width.
	mm	mm	mm	mm.	mm	mm	mm	mm	mm.	mm	mm	mm
Enfield ..	190	68	38	86	400	109	37	58	240	86	35	95
Kapua ..	190	68	88	87	880	108	35	56	241	86	85	99
Glenmark ..	184	69	38	81	898	109	37	47	254	92	86	94

On the supposition, therefore, that the three deposits of bones are of the relative ages here put down, we find that during the interval *M. casuarinus* became larger, especially in the tibia and femur. In *M. didinus*, on the contrary, the metatarsus and tibia remained practically the same,* while the femur got smaller. The two, therefore, differentiated

* The Kapua birds, however, had a smaller tibia.

from an intermediate ancestor. The relative numbers of the two species were as follow: At Glenmark *M. casuarinus* was four times as numerous as *M. didinus*; at Kapua it was four and a half times as numerous; while at Enfield *M. didinus* was nearly twice as numerous as *M. casuarinus*, so that *M. casuarinus* decreased and *M. didinus* increased, relatively, between the dates of Glenmark and Enfield.

This is only advanced as a suggestion for other collectors to follow up. It may prove to be wrong, or it may lead to observations which will establish the direction of development of the moas.

LEG BONES FROM GLENMARK.

MEIONORNIS.

DIAGRAM OF THE TWO PRINCIPAL MEASUREMENTS, LENGTH AND MID. WIDTH OF SHAFT, IN INCHES.

—	Inches.	2·1	2·0	1 9	1 8	1 7	1 6	1 5	1·4	1 3
Tibia.	19 5	.	..	..	1*a*	2*a*	..	..	..	.
	19 0	..	..		8*a*	2*a*	2*a*	1*a*	..	..
	18 5	.	..	..	5*a*	12*a*	15*a*	2*a*	..	..
	18 0	..	..	..	..	6*a*	17*a*	6*a*	..	..
	17 5	..	..	..	1*a*	4*a*	12*a*	5*a*	..	..
	17 0	..	..	..	..	1*a*	6*a*	1*a*	..	..
	16·5	.	.	.	..	..	.	..	1*b*	.
	16 0	.	.	..	..	..	..	6*b*	..	..
	15·5	..	..	..	..	..	..	2*b*	6*b*	2*b*
	15 0	.	..	..	..	..	1*b*	1*b*	1*b*	1*b*
	14 5	..	..	..	..	..	..	..	1*b*	2*b*
	14 0	..	..	..	..	..	..	..	1*b*	2*b*
Femur	12·0	..	..	..	..	..	..	..	..	..
	11 5	..	..	.	..	1	..	..	..	..
	11 0	..	..	..	2	4	18	6	..	..
	10 5	..	..	..	2	2	15	20	4	.
	10 0	..	..	..	..	8	5	11	2	.
	9 5	..	..	..	..	..	2	3	3	3
	9 0	..	..	..	..	..	..	4	2	3
	8·5	..	..	..	..	..	..	..	..	1
Metatarsus.	9 5	..	..	..	..	..	..	..	..	.
	9 0	..	..	..	2	1	..	..	..	.
	8 5	..	..	..	5	15	11	..	..	..
	8 0	.	..	..	11	19	17	6	..	..
	7 5	..	.	.	..	5	5	7	3	.
	7·0	.	..	..	..	..	4	7	6	..
	6 5	..	..	..	..	..	..	1	1	2

a. M. casuarinus.

b. M. didinus.

ART. LII.—*On Two Moa-skulls in the Canterbury Museum.*

By Captain F. W. HUTTON, F.R.S., Curator.

[*Read before the Philosophical Institute of Canterbury, 6th May, 1896.*]

THE publication in the thirteenth volume of the "Transactions of the Zoological Society of London" of the valuable paper by Professor T. J. Parker, F.R.S., "On the Cranial Osteology of the Dinornithidæ," has enabled me to offer descriptions of two rare moa-skulls in the Canterbury Museum, which differ much from any of those described in Professor Parker's paper. In neither case is it quite certain to which species these skulls should be referred; but, as each was found in association with a very limited number of bones, the specific names attached to them are probably correct. In describing them I have followed the terminology and measurements employed by Professor Parker.

Megalapteryx tenuipes.

The first skull is a much-damaged cranium which was found in a limestone cave on the Lower Buller River, together with bones of *Megalapteryx tenuipes* and *Anomalornis parvus*. As the skull of the latter is well known, it follows that one under review belongs, almost certainly, to the former species, and this is borne out by an examination of the specimen, which, although fragmentary, presents characters not found in any described genus. It is the specimen mentioned by Professor Parker in a foot-note on page 378 of his memoir.

The occipital foramen is very large, and its plane about vertical; the crest is large, as in *Meionornis*. The occipital condyle projects considerably beyond the crest, and beyond the par-occipital processes, which are short and rounded below; the supra-foraminal ridge is not continued on them. The cranial roof is much arched, but it is so worn away that an exact description cannot be given; however, the temporal fossæ appear to resemble those of *Meionornis*, and there is a flat area between the temporal and lambdoidal ridges. The former of these is very slightly marked. The inferior temporal ridge is well marked, and the post-temporal fossa is moderate, being broader than in *Meionornis* and narrower than in *Anomalornis*. The roof of the orbital cavity is very flat, and is not separated by any sharp ridge from the temporal fossa—a character by which this skull can be readily recognised from any other as yet described; but there is a slight indication of the groove found in *Anomalornis*. The lower margin of the optic foramen is a sharp, straight shelf of bone, both it and

the pre-sphenoid fossa resembling much *Pachyornis elephantopus*. The inter-orbital septum is better developed than in any other species of moa yet described The basi-pterygoid processes are slender.

Length of basis cranii, 28mm , length to olfactory chambers, 47mm.; width at temporal fossæ, 38mm.; height of cranium, 33mm.; distance between optic foramina, 9mm.; height of occipital foramen, 11mm , width of occipital foramen, 10mm.

The leg-bones—a tibia and a metatarsus—which I believe belong to this skull have the following dimensions :—

—	Length	Prox Width	Mid Width	Distal Width.
Metatarsus ..	173mm.	45mm	27mm.	74mm.
Tibia	362mm.	81mm.	25mm.	27mm.

Anomalornis fortis.

The second of these skulls is a cranium and mandible found in a small swamp at Cheviot, together with leg-bones of *Dinornis torosus*, *Megalapteryx tenuipes*, *Anomalornis fortis*, and *Anomalornis parvus*, those of *A. fortis* being the most numerous. If I am right in ascribing the skull from the cave on the Buller River to *Megalapteryx*, it follows that the present skull belongs to *Anomalornis fortis*, and this opinion is considerably strengthened by the fact that the mandible bears a considerable resemblance to that of *A. parvus*.

The cranium is considerably damaged, but the following description will show that it differs from any hitherto described skull :—

Cranium.—The occipital plane is at right angles to the basi-temporal platform, and the occipital crest is low and broad, as in *Pachyornis*. The condyle projects beyond the crest, and beyond the par-occipital processes. These latter are damaged, but they appear to be much the same as in *Meionornis*, except that they are smaller and do not project downwards to the level of the mammillar tuberosities. The supra-foraminal ridge is well marked, and can be traced on each side all down the par-occipital process. The lambdoidal ridge is simple. The cranial roof is much arched in both directions, but without any swellings. The post-orbital processes are broken off, as are also the margins of the orbits. The base of the skull also is much damaged, but the mammillar tuberosities are seen to be feeble and ridge-like, as in *Meionornis*. The tympanic cavity (much damaged) has its dorsal margin curved. The zygomatic process is very slender. The inferior temporal ridge is well marked, and the post-temporal fossa is very

broad, as in *Anomalornis* and *Pachyornis*, and very different from *Meionornis* and *Euryapteryx*. The temporal fossa is much the same as in *Meionornis*, the temporal ridge not extending much over the cranial roof, and leaving a flat area between it and the lambdoidal ridge. There is no mid-temporal ridge. The roof of the orbital cavity, from the optic foramen towards the middle of the upper margin of the orbit, is remarkably flat, and is separated from the sharp ridge which forms the anterior margin of the temporal fossa by a deep groove, as in *Anomalornis* The optic foramina are damaged, but, apparently, they resemble those of *Anomalornis parvus*.

Mandible.—This is stronger and straighter than in *Meionornis*, but not so robust as in *Anomalornis parvus*, nor so pointed or so deflected as in *Pachyornis elephantopus*. The articular cup is much expanded, the outer border reflexed, the inner border quite low and with a pneumatic foramen on the inner surface near the end of the internal angular process. In these points it resembles the mandible of *Anomalornis* and *Pachyornis*, and differs from that of *Meionornis* and *Euryapteryx*. The symphysis is longer than in *M. casuarinus*, but not so long as in *A. parvus*, which it otherwise resembles. The ventral ridge is fairly well marked.

The following measurements are all that can be given; they are taken in the same way as those in Professor Parker's paper:—

Length of basis cranii, 28mm.; length to olfactory chambers,* 50mm.; width at temporal fossæ, 42mm.; distance between temporal ridges, 36mm.; height of cranium, 37·5mm.; distance between optic foramina, 10mm.; length of mandibular ramus, 118mm.; greatest height, 17·5mm.; least height, 10·5mm.; length of symphysis, 17mm.; width of symphysis, 22·5mm.

Both the cranium and the mandible closely resemble those figured by Sir R. Owen under the name of *Palapteryx* in "Extinct Birds of New Zealand," pl. 45, figs. 1–7; but in our specimen the cranium is more arched, the temporal ridges do not extend so far over it, and the occipital condyle is more rounded in section. However, I believe the two to be congeneric.

The cranium agrees with that of *Anomalornis parvus* in the broad post-temporal fossæ, the groove on the roof of the orbital cavities, and probably in the structure of the optic foramina and pre-sphenoidal fossæ. It agrees with that of *Meionornis casuarinus* in the shape of the temporal fossæ and

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* Measured from the centre of the occipital condyle to the anterior border of the upper portion of the septum separating the olfactory chambers from the brain-cavity.

in the flat areas between the temporal and lambdoidal ridges. In the curved dorsal margin of the tympanic cavity it differs from both, but this part is much damaged. The mandible more closely resembles that of *A. parvus* than that of *M. casuarinus;* but it is slighter and more curved than in *A. parvus.* The pelvis and sternum, described in my paper on the moa-bones from Kapua,* are also intermediate between *Meionornis* and *Anomalornis*, but, as the pelvis, the leg-bones, and the mandible approach more nearly to the latter genus, I think the species has been rightly named. Too much importance appears to have been attached to the spread of the temporal ridges over the cranial roof, which is of specific value at most. If, however, it is thought to be generically distinct from both, it may take the name of *Palapteryx.*

The dimensions of the leg-bones which I believe to belong to this skull are as follow:—

—	Length	Prox. Width.	Mid. Width.	Distal Width.
Metatarsus	180mm.	58mm.	35mm.	81mm.
Tibia	406mm.	96mm.	33mm.	48mm.
Femur	245mm.	83mm.	34mm.	86mm.

These measurements are much the same as those of the large form of *A. parvus* found in caves, and, indeed, I cannot distinguish the metatarsi of the two species, but the femur in *A. fortis* has the popliteal depression deeper, and the tibia is easily recognised by its not having the distal inward dilatation in the neighbourhood of the flexor bridge which makes the tibia of *A. parvus* look something like that of *Pachyornis.*

Art. LIII.—*On Alterations in the Coast-line of the North Island of New Zealand.*

By C. F. Maxwell.

[*Read before the Auckland Institute, 19th July, 1896.*]

Being in the habit of doing a considerable amount of travelling along both the east and west coasts north of Auckland, I observed certain changes which are taking place in the configuration of the coast-line, these alterations being more particularly

* Trans. N.Z. Inst., xxviii., p. 639, 640.

marked on the west coast. They consist of apparent encroachments of the sea on the land, and a gradual eating-away of those portions of the coast-line which, not being protected by dykes of hard rocks or banks of drifted sand, are exposed to the wash of the tides. In many places that I can call to mind between the Manukau Heads and the North Cape this process of denudation is going on at an active rate.

In the Manukau Harbour extensive stretches of mud-flats exist, with stumps of trees, some of them of great size, still showing, though in most cases they have been eaten level with the surface by the *Teredo navalis*.

In the Whangape Harbour in particular, within the memory of men still resident there, many acres of once-cultivated land have been swept away, and nothing is now left but bare mud-flats, showing here and there the stumps of some of the larger manuka or other woods sufficiently deeply embedded in the subsoil to resist the ravages of the waves for a time at least. So persistent is the attack of the sea that the Natives have been compelled to protect the face exposed to the waves with breastworks of split timber, in order to save some of their most fertile kumara plantations from totally disappearing.

These facts seem to indicate that at some previous period most of these mud-flats were low-lying stretches of alluvial land, covered with forest, which have been encroached upon by the wash of tides gradually rising higher, and the vegetation destroyed by the salt water, until finally nothing was left but the present stretches of mud-flat, bare for miles at low water.

The coast-line from Kaipara Heads to Maunganui Bluff, many miles in length, shows very distinctly that the sea has made inroads on the solid land, or, in other words, the land projected much further into the ocean at one time than it does at present.

The coast-line is remarkably straight, and, as the formation is similar throughout, the erosive action must be very regular along the whole line.

The general appearance of the coast is a very flat, hard beach, with very little shifting sand, extending to the base of soft sandstone cliffs ranging from 60ft. to 100ft. in height. During high spring tides, with westerly winds or westerly gales generally, the seas beat against the foot of the cliffs and wash out the softer seams of sandstone, when, the face being undermined, large masses break off and come tumbling down on the beach to be speedily swept away by the breakers.

Exposed in the face of the cliffs are seams of lignite, one above the other, ranging from a few inches to several feet in thickness. This substance appears to be of recent origin, for in places huge trunks of trees belonging to the natural order

of *Coniferæ*, though differing somewhat from the kauri (*Dammara australis*), project in a semi-carbonised state, proving that at a comparatively short time before they were still embedded in the seams of lignite.

Within the Hokianga River, also, the same destructive process is in operation, and wherever the sea comes in contact with those places where the soil is not composed of stiff clay or rock-bound, its ravages are only too evident.

On the east coast a different state of things prevails. A close examination of different points along the coast-line gives one the impression that high-water mark has receded of late years, and, so far from the sea encroaching, the land is actually making along the whole eastern coast north of Auckland.

A casual remark by the captain of a coasting steamer, who has been trading on the coast for years, that "the harbours on the east coast are shallowing perceptibly," in addition to what I had observed on the west coast, led me to devote some thought to the subject, for, if correct, the inference is that the west coast of the North Island, so far as I have had an opportunity of observing it, is gradually subsiding, and the east coast becoming correspondingly elevated.

There may be scientific and satisfactory reasons for these interesting phenomena, but until explained to us by a scientist it only remains to take facts as we find them.

The captain's theory to account for the decrease in depth of the harbours he is in the habit of visiting was that the increased cultivation in the interior, and destruction of the forests beneath the axe of the settler, caused a larger quantity of silt than formerly to be brought down in freshets, and deposited on the anchorages; but, as the same causes do not apparently operate on the west coast, it seems to point to the weakness of the explanation.

It seems to be fairly well established that the low lands surrounding the Rangaunu estuary, and extending up towards the old mission-station of Kaitaia, were at no very distant period covered with salt water, as settlers, while sinking wells on the Kaitaia and Awanui flats, have penetrated at a greater or less depth into solidified mangrove mud, with portions of the trunks and roots of mangroves still *in situ*.

It seems probable that as time goes on most of the present extensive mud-flats in this locality will gradually become covered with silt, and eventually be rendered fit for cultivation. Within the last thirty years much land formerly useless on account of being covered by the tides, has now become sufficiently elevated above the water-level to be available for cultivation, and is being utilised for that purpose. At more than one place—notably at Te Mahia, between Gisborne and Napier—the natives have traditions that at one time the sea

flowed over what is now dry land, and what are now headlands were then islands, with channels of considerable depth between them and the mainland.

If these few remarks should arouse sufficient interest in the subject to prompt some competent observer to investigate and throw some light on the natural forces at work on our coastlines I shall feel well repaid.

Art. LIV.—*On Artesian Water Prospects in Poverty Bay and Gisborne.*

By H. Hill, B.A., F.G.S.

[*Read before the Hawke's Bay Philosophical Institute, 12th October, 1896.*]

The Town of Gisborne, in the Poverty Bay district, is situated a little to the eastward of the 178th degree of east longitude, and about 38° 23′ south latitude. To the west and north-west of the town a plain extends of some 15,000 to 20,000 acres in extent, through which the Waipaoa River and several smaller rivers flow to the sea. The Turanganui River, on which the Town of Gisborne stands, is made up of two streams—viz., the Waimata and Taruheru. Neither of the rivers named as flowing into the bay is a shingle-carrier, and, as far as I have seen, there is no trace of shingle along the beach between the town and Young Nick's Head, on the south bend of the bay. Near the new freezing-works there is a pumiceous chalky-like material which rims the lower front of the Kaiti Hills, facing the town. The substance may be described as tough rather than hard. It is very absorbent, and weathers well on exposure. There is no trace of its junction with the adjoining rocks, although in the exposed bands of fine sandstone which are exposed along the eastern side of the breakwater at low-water there are traces of this rock met with, and it appears to be resting unconformably on the sandstones. A similar deposit is met with on the opposite side of the bay, between Te Arai and the Murewai, where there is an isolated hill of from 50ft. to 60ft. high, composed entirely of this pumiceous chalk-like material. The rock appears to strike across country from north-east to south-west, for it appears along the coast in the vicinity of Gable-end Foreland, and it is also met with on the Gisborne–Wairoa Road, between Panikanapa and the Upper Patutahi.

The tops of the hills eastward and north-eastward from Gisborne, as far as Tua-motu Point, are covered with a heavy

deposit of nearly pure, coarse pumice, overtopped by a thin coating of shingle, which passes towards the point into old sea-beach deposits made up of sands, boulders, and a kind of impure cemented limestone full of recent shells. The deposits, wherever exposed, rest unconformably upon the underlying beds, which are highly inclined towards the west and north-west. The pumice and beach deposits are of varying thickness, but in the exposed face of the hills opposite the native church on the Kaiti they must be at least 130ft. in thickness, and show bands of stratification as if laid down in a slowly-subsiding water-area. Similar deposits cover the tops of all the hills to the west and north-west of the Poverty Bay plain, and they continue to top the hills and fill the valleys as terrace deposits to the north-west beyond Ormond, in the direction of the district known as Mangatu. All these deposits are of fresh-water origin, and in some of the finer pumice beds beautiful leaf specimens are met with. All the beds are very porous, but they are of limited extent in their distribution, for, although they can be traced over the larger portion of the present basin of the Waipaoa River, they are limited in other directions, and form no area of accumulation of any extent. They are not met with in the direction of Patutahi, although the low hills near Mr. Sutherland's residence are capped with a heavy silt-deposit, under which traces of shingle might be expected, followed by limestones similar to those to be met with at the Ormond quarry. The higher hills to the north, north-west, and west are capped here and there by limestone, with which most Gisborne residents are familiar, as it is used for metalling the county and borough roads; and Mr. Oxenham, of Makauri, also uses it for the manufacture of lime. This limestone belongs to the same geological series as that at Patutahi (lower and upper), which crops out on the road-side as you proceed from the plain towards Waerenga-o-kuri. The same limestone is met with at the waterfall between Scott and Weatherhead's, and it strikes across the country in a north-east direction, and eventually merges further on into a fossiliferous sandstone. No limestones are met with on the Kaiti or on the hills in the immediate vicinity of Gisborne, nor is there any trace of limestone on the hills in the Murewai district, in the vicinity of Young Nick's Head.

Turning to the lower or underlying rocks, the general character of these can be seen in the exposures facing the bay along the Kaiti Beach. The rocks are banded, being made up of blue clays and soft thin sandstones interbedded and dipping or sloping in the direction of the town. The clays wear quicker than the thin bands of sandstone, and the latter break away in slab-like masses as the clays wear down by the action of the atmosphere. The thickness of the beds is very great,

and cannot be less than 5,000ft. or 6,000ft. All the beds are conformable, and dip at an angle of about 25° in a north-west direction, and pass beneath Gisborne in the direction of Ormond at a varying depth. The rocks which make up the series known as Young Nick's Head, along the south side of the bay, have no corresponding characters with those described as dipping beneath the Poverty Bay plain. They are younger, and are connected with the beds forming the hills on the Whautaupoko, although there is apparently a fault of some extent, as the dip of the beds at the Murewai is south-south-east, whilst those on the Whautaupoko is south-west. The rocks exposed on the right bank of the Waipaoa River, opposite Ormond, belong to the Nick's Head series, and they dip E. by N. towards the bay at a low angle.

From the descriptive account here given it will be noticed that, although there are numerous porous rocks in the district, they are by no means generally distributed, nor do they form a syncline and dip generally in the direction of the plain. The limestones are not conformable with the clays, and unfortunately they dip north by west, and their drainage is mainly in that direction. The lower rocks in the vicinity of the plain have been much tilted and broken, and, except in the case of Kaiti and Ormond, underlying beds do not present any prospect of a syncline such as is required for an efficient artesian water-supply basin. As already explained, the rocks forming the lower hills on the Whautaupoko are porous, being made up of shingle, sands, lignite, and a coarse, fossiliferous, marly sandstone, which seems to pass into an impure limestone in the direction of the Ormond quarries. These beds are to be found in isolated spots on the Patutahi side of the district, and between them and over them the Waipaoa River passes on its way to the sea. All these beds correspond with what are known as the Kidnapper beds, in the Hawke's Bay district, and from which the artesian waters of Napier and the whole of the surrounding plain are drawn. In the latter district, however, they are much more extensive, and they form with the limestones a trough or syncline of large extent, and which constitutes the artesian basin in the district.

The plain extending from Gisborne in the direction of Patutahi and Ormond is of very recent formation, and is made up chiefly of the *débris* carried down to the sea by the Waipaoa and the other streams which fall into the bay. There have been some differentiated earth movements in the district, and these, along with the deltoid deposits, have produced the present plain and coast lagoons. When these changes began the bay was a deep arm or inlet of the sea, and the Waimata River ran through the Kaiti Valley, which at the time of high water was washed by the sea. The areas have been slowly

filled up by the process of denudation from the hills, and by means of the material which the rivers have brought down in the wet season. An imaginary line from the top of the Kaiti Hill to the hills behind the Hon. Mr. Carroll's homestead, on the Whautaupoko, thence across the lower Patutahi Hills, near Mr. Sutherland's, and onward to the hills up the Ormond Valley, joins together all the porous beds which at one time covered the whole of the intervening area.

It will be noticed how great the changes in the land features have been since these contemporary deposits took place. I am in doubt whether the whole of the enclosed area forming the plain is one of denudation and deposition or of depression and deposition. It may be there is a combination of the two, as there is evidence in support of each. The sinkings for artesian water that were carried out in several spots within the Gisborne Borough some years ago show a denuded surface only, but the wells at Matawhero and Makauri imply an area of depression, followed by one of deposition, from the material which the Waipaoa River has brought down and deposited over a deltoid area.

If the plain was the outcome of denudation only there would be little hope of finding an artesian-water supply, and even as an area of depression the enclosed basin may be expected to be of small extent, and special care is needed in the selection of a suitable place for putting down a trial bore. I have pointed out that the Waipaoa River passes across the trough of the porous beds which are to be found in different places within the boundaries of the district. These beds are absent, except the upper very recent ones, within the limits of the Gisborne Borough, and this is the reason why water was not met with in the trial bores that have been put down. The beds that dip under the town are those belonging to the Kaiti beach series, and they are mainly made up of clay, and are impervious to water; besides, the outcrop of the beds cannot possibly have more than a tithe of the quantity of water needed for the supply of the town, as the area of drainage of the outcrop beds is too limited in extent. It is quite useless to attempt sinking for an artesian supply within the limits of the borough—at least, I could not recommend any one to do so, because the money would be wasted, as there is no real artesian basin in the immediate vicinity of the town. But within certain limits the prospects of obtaining an artesian supply are good, the limits being within what appears to me as the area of depression to which reference was made above. This area is not of great extent, but it is sufficiently large to allow of a fair number of wells being put down should the water be suitable for domestic purposes. The line of depression extends in a line from Ormond to the most easterly

point of Young Nick's Head, and passing through Waerenga-hika, Makauri, Matawhero, and thence to the sea-beach. On either side of this imaginary line a trough exists, and I have no doubt artesian water would be obtained from it. Already tests have been made, as in the wells at Makauri and Makaraka, and with proper appliances wells might be put down of sufficient bore to provide an ample supply for the wants of Gisborne. The best place for putting down a well would be near the native settlement, towards the sea-beach, in a line between the cape and Matawhero.

I am unable to say anything as to the quantity or quality of the water likely to be obtained. A knowledge of these can only be gained by experience. The Waipaoa River is not a shingle-carrier like the rivers of Hawke's Bay, and I do not expect a flow equal to what is obtained in the Hawke's Bay district, nor do I suppose that the water will possess the same general qualities. But these matters can readily be put to the test at comparatively small cost. A trial bore, with a 2in. pipe, should be made by the local governing authorities, such as the County Council and the Gisborne Borough. The work could be done in ten days or so, and the information gained would provide information for the district, and it would set at rest the possibility of supplying Gisborne with water of a quantity and quality suitable for the needs of the town.

As my description of the district is written in a popular form, and free from technicalities, I have omitted sections of any kind, as the account can be readily followed by any one having even a slight acquaintance with the district.

ART. LV.—*On a Volcanic-dust Shower in Napier.*

By H. HILL, B.A.

[*Read before the Hawke's Bay Philosophical Institute, 14th January, 1897.*]

I WISH to place on record a storm of volcanic dust which fell in Napier on the night of the 14th December and early in the morning of the 15th December last. A strong wind had been blowing from the north-west on the previous day, and clouds had been seen coming from that direction, but nothing unusual was expected from this circumstance. The evening of the 14th was rather boisterous, but it was not until early in the morning of the 15th that the falling dust was noticed, except in one or two cases where clothes were being taken in from the drying-

line late at night. In these cases it was noticed that the clothes were covered with a fine grey dust, but it was supposed to have resulted from the dryness of the ground in the vicinity. Early on the 15th those who were up noticed dust falling on their clothes. This was especially noticeable on the western and north-western side of the town, where the quantities that fell enabled several bottles to be filled from the roofs of the houses. Mr. Arthur McCarthy, who lives on Battery Point, brought me some of the specimens collected by him, as did also Mr. Yuill. These were gathered from different localities, but they are similar in every particular. One of the officers of the borough prison gathered some of the dust, and I also gathered some at the Athenæum rooms and at my own house. The specimens I have are exactly similar to the fine dust which fell on the deck of the steamer "Southern Cross" as she was passing along the Bay of Plenty on her way to Napier on the morning following the Tarawera eruption in July, 1886.

In order to obtain the fullest information concerning the distribution of the dust, I wrote a few lines to each of our local papers asking for information, but no one outside Napier appears to have noticed any dust except Mr. Peters, who has the mail-contract for the coach-line between Moawhango and Tokaanu. There had been telegrams announcing volcanic explosions at Tongariro, and he informed me that Te Mari had burst out in a fresh place, and that a number of dust-showers had occurred. The country extending from Roto Aira to the Wai-o-ho-nu Stream, in the direction of the Onetapu Desert, had been covered with volcanic dust to the depth of 2in., and most of the vegetation had been destroyed. He stated that the dust-storm had reached Tokaanu, and that he noticed the wind, when it changed to the west and north-west, carried an immense black cloud in the direction of the Kaimanawa Mountains, and he supposed that portions of the cloud, which was full of dust, reached Napier.

I have not been able to find out whether the district has been visited by a similar storm within the memory of any living colonist, but the recent shower is a full testimony as to the truth of the statement made by me in a paper that was read before our Society in 1886, entitled "Traces of Volcanic-dust Showers at Napier and Petane,"* wherein it is stated that "in and around Napier a large percentage, in fact the larger portion, of the soil is of volcanic origin."

The last eruption of Te Mari was in November, 1892. It was visited by me on the 1st January, 1893, and a description of it appears in the Transactions, vol. xxvi., art. xliii.

* Trans. N.Z. Inst., xix., art. xlix.

V.—CHEMISTRY.

Art. LVI.—*On the Bromine Method of Estimating Sulphur in Gaseous Compounds.*

By Dr. W. P. Evans.

[*Read before the Philosophical Institute of Canterbury, 30th November, 1896.*]

A slight modification of the well-known Harcourt method of estimating sulphur in coal-gas seems capable of rendering good service in the analysis of gaseous substances in general.

For coal-gas a very simple form of apparatus gives excellent results. The gas is passed at the rate of about 25 litres per hour through any convenient form of absorption-flask; then through a combustion-tube packed for about 6in. of its length with platinised asbestos, and kept at a good red heat; and lastly through a second absorbing-flask (Winkler spirals or ordinary 10-bulb tubes answer extremely well as absorbing-flasks). The two flasks are charged with bromine water acidulated with hydrochloric acid. The first flask gives those sulphur compounds which are directly oxidized by bromine water, the second those which are only oxidized after passing the layer of heated platinum.

In coal-gas this practically means that No. 1 gives the sulphuretted hydrogen and No. 2 the carbon-bisulphide. If, as is generally the case, only the total sulphur is needed, then the first absorbing-flask is, of course, to be omitted. The apparatus, once set up, needs no further attention. The only precipitate is the well-known barium-sulphate, and the results obtained are more than accurate enough for any technical purpose.

Art. LVII.—*Refraction and Reflexion of x-rays.*

By Dr. W. P. Evans.

[*Read before the Philosophical Institute of Canterbury, 30th November, 1896.*]

While taking an *x*-ray photograph of a set of chemical weights a very unlooked-for result was obtained. The weights were of the cylindrical pattern, and had exceptionally well-polished surfaces. They were placed in two

rows, one on each side of the x-ray tube, and at varying lateral distances, so that the angle of incidence of the rays varied considerably throughout the series. In the case of those farthest from the tube, and where, therefore, the angle of incidence was comparatively large, nothing but the well-defined and highly-distorted shadow was obtained. Where, however, the angle of incidence was small, the side of the shadow nearest the tube was bordered by a dense crescent-shaped band, varying in thickness from nil to 0·8mm. The experiment was repeated, and the same result obtained. The sharpness and extent of this reflexion crescent depended on the temperature of the tube and the angle of incidence. A common brass set gave no such reflexion effect, probably because their surfaces, though smooth in the ordinary sense of the word, were rough compared to those of the highly-polished platinum. A gilded weight gave a slight image as long as it was dry.

In consequence of this experiment some of Röntgen's earlier experiments were repeated, with the result that glass in the form of powder showed a distinctly greater absorbing-power than the same mass in sheet form. If there were no reflexion or refraction of the rays at the faces of the small pieces of glass the powdered glass and the original plate should both have the same effect. These experiments tend to show that the x-ray vibrations are probably transverse, and of extremely short period.

Art. LVIII.—*On the Position that Cyanogen holds in relation to the Simple Radicals, and its Inability to combine directly with Silver or Gold.*

By William Skey, Analyst to the Department of Mines.

[*Read before the Wellington Philosophical Society, 26th August, 1896.*]

Abstract.

In this communication I refer to the fact that in 1874 I gave a paper to this Society entitled "On the Analogy of Cyanogen to Oxygen,* in which I endeavoured to show that this compound radical should not, for certain reasons that I stated, be classed as it now is with the haloid elements chlorine, bromine, and iodine, but rather with oxygen; that, in fact, it is only when it is united with sulphur that we have a

* Trans. N.Z. Inst., vol. vii., p. 379.

radical at all comparing with the elements here named. This theory, when circulated in England, did not meet with any favour, not that the facts I adduced in support of it were at all questioned, but that others were put forward which, as was stated, conflicted with them. Not then having any further facts to adduce I let the subject drop; but just recently, owing to the question assuming considerable importance, I took it up again, and I have, as a result, discovered further evidence, which, as I believe, is greatly in favour of my theory, and which I adduce I, therefore, state this evidence, which is to the effect that cyanogen does not, as it is at present supposed, dissolve either silver or gold when administered to it as an aqueous solution, whether these are dilute or concentrated—that, indeed, as far as I have at present investigated the matter, cyanogen does not even attack either of these metals at all.

The exhibits 1 and 2 on the table here show a little silver and gold leaf that have been in a strong solution (aqueous) of this gas for five days, and, for comparison, pieces of silver and gold leaf, from the same sheets respectively, that have not been in the solution. I do not think any one can discern any difference in the appearance of these—that is, any loss of either the gold or silver leaf that has been in the cyanogen; and I think that you will allow that this is a very severe test in the case of gold, when you consider that its thickness is not more than $\frac{1}{170000}$in. To get a still more crucial test I have coupled gold leaf with chalcopyrites in the solution of cyanogen (as you may see in the exhibit No. 3), so as to have the benefit, the stimulating effect, that we get by allowing any electricity produced by chemical action to become current electricity. Still, you may see the result is the same; the gold remains, as far as we can see, *absolutely unaffected.*

In all these experiments I feebly acidulate the cyanogen solution to counteract the decomposing effect produced by atmospheric ammonia or the alkali of the vessels that I use. Thus I completely avoid the production of gold-dissolvers—that is, the alkaline cyanides which otherwise would interfere with the accuracy of investigations of this nature.

Light does not appear to act on these solutions of cyanogen, at least so as to produce any solvent for gold, such as ammonium-cyanide.

I, then, assert that cyanogen gas, like oxygen, is far more soluble in water than in saline solutions generally that have no chemical effect on it, but that, as it now appears to me that this is a general character of gases, I do not count upon this fact to aid me in my contention. I, then, go on to state, in regard to the position of this compound radical among the elementary radicals, that wherever this is, it cannot be with the

group of chlorine radicals, owing to the non-acidity of its hydride in water, the composition of its acidic compounds with oxygen, and lastly, as here shown, its refusal to unite directly with certain metals.

I, then, in conclusion, state the position I would take in the controversy that I started, and it is this: that, while not disputing the correctness of the general opinion that cyanogen stands in close relation to the radical carboxyl, in which case it is monoatomic, and so comparing with the chlorous radicals, I still maintain that it is on certain occasions diatomic, and so comparable with oxygen. It has, in fact, as I believe, a varying atomicity or quantivalence, according to the nature of its environment.

As you are aware, this compound can assume allotropic states—that is, like oxygen, it can combine with itself—and an intercombination such as this might, I think, give us cyanogen in the form of a "dyad"; but this is a matter that requires further consideration.

It is only right that I should inform you that Professor Black, of the Otago University, has proved by a series of experiments which are practically contemporaneous with mine that if cyanogen does dissolve gold it is only at a very slow rate as compared with the action of potassic cyanide on this metal. However, as it appears that a very suggestive query that I proposed bearing on this matter started this gentleman on these experiments, I feel sure that this gentleman will, with his accustomed magnanimity and feelings of good-fellowship for his brother-workers in the field of science, concede to me the position of leader in this investigation.

Art. LIX.—*Further Results showing that Free Cyanogen does not dissolve or even attack Gold.*

By William Skey, Analyst to the Department of Mines.

[*Read before the Wellington Philosophical Society, 7th October, 1896.*]

The scientific and other interests that attach to the statements I made before the Society a few weeks ago, that free cyanogen does not attack gold, has induced me to continue my investigations on the subject by the application of tests of a more severe character even than those were upon which I based this statement.

I should premise the description of the results of this further investigation by informing you that soon after the

paper referred to was read I learned that Mr. Park, late Lecturer at the Thames School of Mines, had made a series of valuable experiments on the subject, in which he used the gravimetric method for determining whether there was not a dissolution of gold by aqueous solution of this gas.

The results of these experiments do not confirm the correctness of this statement of mine (that cyanogen is unable to dissolve gold), but, still, they clearly show that, at least, solutions of this gas do not dissolve this metal at all readily. Mr. Park informs us that he performed his experiments with a button of pure "parted" gold gently hammered to a coherent spongy mass of about $\frac{1}{8}$ in. in diameter, and weighing 0·340 grain. This button was placed in an aqueous solution of cyanogen and the containing vessel loosely covered Upon again weighing this button, at intervals of twenty-four hours, he found there was generally a loss of about $\frac{1}{350}$ of its weight at every weighing—that, in fact, about $\frac{1}{1000}$ gr. of gold dissolved per diem.

This does not appear to be a great loss; still, it is very much more than I should have anticipated, but, knowing that the most recent works on chemistry to hand in the colony decide that cyanogen in water alone does not decompose to substances solvent of gold, this scientist could not support my contention as he desired to do.

It was this unsatisfactory state of the case that induced me to make further researches in the matter. Now, as you are aware, cyanogen is a substance that in the presence of even minute traces of ammonia or potash is decomposed to form alkaline cyanides which are solvent of gold, and when once this action starts it proceeds with ever-increasing rapidity. The atmosphere of a laboratory in full operation is frequently alkaline; the vessels used for receptacles in chemical work are capable of yielding alkaline matter to cyanide solutions. For these reasons any experimental results obtained in a laboratory are likely to be misleading.

It is evident, therefore, that any method which requires considerable periods of time, such as the gravimetric method does, is not well adapted for this kind of research; one is required that will speedily give reliable results. Eschewing, therefore, the use of even the hypothetical just balance as an abomination in this case, I adhered to my old method, which is that of testing by sight alone whether any loss of gold does occur by the action of free cyanogen. For this I merely replaced the gold leaf of my former experiments by gold paper, which is a Swedish filter-paper, in which gold has been chemically precipitated in a very finely-divided state. A sample of this test-paper is tabled here for exhibition, and the red tint of its gold is easily perceptible in this paper,

$\frac{1}{10}$in. square, by contrasting it with the same kind of paper that has not been so treated. A few short statements showing the extreme tenuity of the gold in this paper may be interesting.

A square inch of the paper contains $\frac{1}{10000}$gr., and $\frac{1}{10}$in. square contains $\frac{1}{1000000}$gr. of gold. Were the gold in this paper agglomerated to a film having a like area with that of the containing paper that film would be only $\frac{1}{5000000}$in. thick—that is, 250 of these would be the thickness of gold leaf. In the paper itself (being, as it is, $\frac{1}{120}$in. thick) this film (of the $\frac{1}{5000000}$in.) is broken up to occupy a volume 400,000 times that which it occupies in the form of a film.*

It follows, therefore, that the gold in this paper, volume for volume, only weighs half as much as hydrogen gas.

Broken up in this manner in the test-paper before you, it is in very truth fine gold—in fact, gold divided almost to its ultimate atom (if, indeed, atoms do exist)—gold in the cloud form, as it were, and therefore in the best condition that I know of for my purpose. Provided with a test so delicate as this is, we get results in an hour that, using the gravimetrical test for loss, would require several days, and so we avoid those errors that are apt to creep in and vitiate our results when long periods of time are required for experiments of this nature.

Placing then in a porcelain vessel a strong aqueous solution of cyanogen, along with a little of this gold test-paper, I closed the vessel down airtight, and on examining at periodic intervals I found that even after the expiration of six hours, corresponding to sixty-two days for gold leaf, there was no visible diminution of the colour of that test-paper. After this, however, the tint gradually faded, until in thirty hours it had quite disappeared. Thirty hours to dissolve the millionth of a grain of gold so finely divided as this gold was, shows that if cyanogen itself does dissolve gold it is only at an extremely low rate—at such a rate that ordinary gold leaf would require about one year to become entirely dissolved therein.

Now, this result is a very different one to those that I am faced with both by Professor Black and Mr. Park; still, while it is clearly shown that for gold-milling the gas cyanogen as a direct solvent is useless, it does show that there is an infinitesimal dissolution of gold either by cyanogen or its derivatives, and in the interest of exact science the question has to be decided which of these it is.

Now, the cyanogen I used, though very carefully prepared, had a slight acid reaction; it contained traces of ammonia, hydrocyanic, and hydrochloric acids, and this even when

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* The method for accomplishing this is given in the "Transactions of the New Zealand Institute," vol. xxv., p. 388.

to avoid producing them I used the protochloride in place of the bichloride of mercury; and I may further state that the solution of this cyanogen kept persistently acid, even when it was three weeks old and much of the gas decomposed; and, what is more singular still, the solution was far more solvent of gold at that time than just after it had been made. It was therefore apparent to me that it is not *any* degree of acidity in a cyanogen solution that does, as is now supposed, conserve this gas—it is not a mild acidity that is always effective for this purpose. So I increased the acidity of the cyanogen solution by adding to it a few drops of hydrochloric acid, and tried another gold test-paper therein, when I was unable to detect, even after the lapse of seven days, the slightest change of tint had been produced upon that test-paper. Hydrochloric acid had not any retarding effect upon the dissolution of gold in weak solutions of bromine.

For supplementary and confirmative evidence on this point I next passed cyanogen gas through a weak solution of nitrate of silver to wash out any ammonia, hydrocyanic and hydrochloric acids contained therein, and the purified gas was then allowed contact with the gold test-paper both as gas and as aqueous solution of it, when I got results altogether confirmatory of those obtained in the previous experiment—that is, no perceivable effect was produced on the test-papers by seven days' contact.

The results of these various experiments, taken collectively, appear to be positively overwhelming in favour of the correctness of the assertion I made before the Society last month—that aqueous solutions of free cyanogen have not the least solvent power upon gold; consequently they support the old contention of mine cited in the former paper, and alluded to here—that cyanogen does not, as is now generally supposed, compare with the haloids, chlorine, bromine, and iodine, chemically—that, in fact, except that it appears to be a monad with these and a dozen or so more of the elements, it has no chemical relations to any of them.

I should inform you that the gold I used for the experiments here detailed, also for those for my former paper to the Society, was practically pure; at least, it only contained minute traces of copper. Argentiferous gold, of which class most or all our native gold is, would, of course, if possible, be still less amenable to solutions of cyanogen than the gold I used, and for the reason that argentic cyanide, if formed at all, would always remain as a product quite insoluble in such cyanogen solutions.

That cyanogen would have very little tendency to form by its decomposition solvents for gold as used upon quartz, &c., at the gold-mines appears to me absolutely certain, as both air

and water are generally acidic, and all the reef quartz I have yet tested also gives an acidic reaction.

Short Notes on the Cyanodizing of Gold.

I will now give you a few notes respecting the cyanodizing of gold, &c., in anticipation of papers I am now preparing on the subjects, and I do so merely to secure myself against being forestalled.

Note 1.

Very finely granular gold, such as that in these papers, or that prepared and described by Professor Faraday, requires far more time (weight for weight) to dissolve in potassic cyanide than solid gold such as gold leaf, the former taking fully a hundred times longer than the latter, and this though the extent of its superficies is comparatively very much greater. This fact appears to me extraordinary, and leads me to suppose, as the only explanation thereof, that the metal, as it exists in the ruby form on the paper here, is in a different chemical state from that of ordinary or massive gold—that is, this gold is in an allotropic form; and, after a most careful perusal of Professor Faraday's celebrated Bakerian lecture on "Gold in its Relation to Light,"* I have come to the conclusion that it so well supports this view of the case that I propose at the next meeting of this Society to lay the whole matter (as far as I know it) before you, in a paper to be entitled "Ruby Gold: an Allotropic State of the Metal."

If this theory is incorrect, the only alternative appears to be one that supposes that solid gold allows of electrical currents being formed, which are helpful towards its dissolution, while the other gold is so finely granular as to afford no room for the play of electrical currents localised in its own separate particles. It cannot even conduct electricity.

Note 2.

Gold leaf placed upon the surface of a strong cyanide solution is whitened throughout before being all dissolved therein. The white film resulting is only very slowly soluble, but if the solution of the cyanide is weakened a good deal the film rapidly dissolves. This film is a cyanide of gold, and its presence under these circumstances confirms the correctness of a statement of mine that in the cyanide process the cyanodizing of the gold is not always, if indeed it is ever, simultaneous with dissolution—that, in fact, the latter process often lags considerably behind the former process.

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* Bakerian Lecture, delivered before the Royal Society, 1857.

Note 3.

Gold leaf as on the surface of a weak cyanide solution is at first strongly positive to the same kind of gold leaf as immersed in this solution; but it very shortly becomes negative thereto, and remains so until dissolution breaks the voltaic connection. The singularity of this circumstance is obvious, when we consider that gold on the solution is far more rapidly attacked by cyanide than is gold which is beneath the surface. This is an interesting fact that requires explanation.

Note 4.

Kerosene, gasoline, and hydrocarbons generally, when placed over gold leaf that rests on the surface of a cyanide solution, do not sensibly interfere with the dissolution of that gold, if only oxygen has free access to the hydrocarbon used. This result shows—(1) That the rapid dissolution of gold leaf as placed on the surface of cyanide solutions is not in part due to the action thereon of "air voltaic circles," as is stated by Professor Faraday in the lecture referred to (the atmosphere itself being cut off); (2) that these hydrocarbon oils are pervious to air, or at least the oxygen of it; and (3) that a very minute quantity of oxygen is as effective for promoting or assisting towards the rapid dissolution of gold leaf resting on such solutions as is an unstinted supply of it.

This concludes the notes that I hope shortly to embody in two papers for this Society at an early date.

ART. LX.—*On the Conductivity of certain Substances hitherto supposed to be Non-conducting for Voltaic Electricity.*

By WILLIAM SKEY, Analyst to the Department of Mines.

[*Read before the Wellington Philosophical Society, 17th February, 1897.*]

IT is generally supposed, and with apparent good reason, that all substances may be polarised, but I do not know that it has yet been proved or asserted that generally all substances are conductors of voltaic electricity, but that such is the case the following results of certain experiments of mine appear to show:—

(1.) A piece of copper wire, heated in an oxidizing flame until its metallic aspect has quite disappeared over the whole surface, then placed in a voltaic circuit with mercury as the anode and cathode, does not break the current, or even reduce it to any notable extent.

(2.) Gold, also platinum, oxidized or sulphurised until they will not amalgamate in clean mercury, can be substituted for copper in the above experiment with similar results.

(3.) Silver, also copper iodized until of a pale-yellow or whitish aspect, can be substituted for copper in experiments, with the same results

(4.) A smooth dry platinum wire plunged in melted beeswax, sealing-wax, or guttapercha, and dipped in again and again until the coating acquired is to be easily seen over its entire surface, can also complete the interpolar connection on dipping its free ends into mercury poles

The conductivity of certain thin films for electricity explains, as I think, the very contradictory statements that have been made respecting the capacity or the incapacity of argentic sulphide to conduct electricity. Long ago Professor Faraday placed this compound among the electric conductors; but that it really does class as such has been disputed, and still is, I believe, disputed. In 1876* I showed, and, as I think, very clearly, that Faraday's statement is correct. Now, I used very thin films of this sulphide in the experiment I made for settling the point in question, and I suppose that those experimentalists who get different results from those of Faraday used the sulphide in a massive form, and gave contact by only a very small extent of surface. If this surmise of mine is correct the whole matter in dispute is at once explained, and it must be allowed that this compound (argentic sulphide) is an electric conductor, but a feeble one

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Art. LXI.—*On the Oxidation of Mercury in Air and Water, also of Iron, in Alkaline Solution.*

By William Skey, Analyst to the Department of Mines.

[*Read before the Wellington Philosophical Society, 17th February, 1897.*]

The Oxidation of Mercury.

About twenty years ago I stated before this Society† that, for certain reasons I at that time gave, the metal mercury should, like gold and platinum, oxidize in air and water conjointly, and I have now, as I believe, succeeded in proving that mercury does oxidize under these circumstances.

The following is a short statement of the results upon which I base this conclusion:—

* Trans. N.Z. Inst., vol. viii., p. 345.
† Trans. N.Z. Inst., vol. viii., p. 342.

1. Clean mercury (as thrice distilled and then filtered twelve times) shaken up with a small quantity of spring water for a considerable time not only breaks up in semi-non-coalescing globules, as one would expect from our present knowledge, but, besides, imparts a slight though persistent turbidity to the water.

2. In distilled water the same effects follow, but they require a longer time to produce them.

3. When aqueous solution of the caustic or carbonated alkalies are substituted for the water these effects are rapidly produced.

4. In weak sulphuric acid mercury breaks up considerably when shaken together after it has had contact for some time, and the liquid also becomes turbid.

5. If weak hydrochloric acid or iodide of potassium be substituted for sulphuric acid turbidity is not produced, and the mercury is not readily broken up.

6. Hydrochloric acid, potassic cyanide, and potassic iodide clear these turbid waters and saline solutions, and more or less agglomerate the mercury.

7. Mercury in strong solution of potash is weakly positive to this metal in both weak solutions of potash and solutions of sodic chloride.

8. Mercury in solutions of potash is strongly positive to itself in hydrochloric acid, and very strongly positive to itself in nitric acid.

9. Mercury in weak sulphuric acid is positive to mercury in nitric acid.

10. Mercury in potassic-cyanide solution is positive to mercury in potash solution.

Now, the only explanation of these facts appears to me to be this: that in the experiments Nos. 1, 2, 3, and 4 the mercury has combined with certain of the elements present, forming in some cases oxides or carbonates, in other cases subchlorides and subsulphates, and these compounds became detached by the friction of the mercury on itself, thus producing the turbidity described; while the effect of the potassic cyanide and iodide, also of the hydrochloric acid in No. 5 experiment, is to dissolve these compounds, thus restoring the normal transparency of the supernatant liquids. The mercury, in fact, for the first series of experiments has (to use the miners' very expressive phrase) floured; had it not floured there would not have been any turbidity produced, and it would not have broken up permanently into small globules as it did.

In the cases where only distilled water was used, or sulphuric acid, it appears certain that the mercury must have been directly oxidized by the air present therein.

The results Nos. 7, 8, 9, and 10 were obtained last, and are strongly confirmatory of the deduction I have made from the results Nos. 1 to 4.

It is not the least singular of these results that the oxidation of the mercury in the alkaline solution is assisted by the oxidation of what I must name the negative mercury by nitric acid. The reason of this is probably that the hydrogen liberated at the negative pole combines with the nitrogen dissolved in the liquid to form ammonia, which, being easily soluble therein, leaves both poles clear of all impediment.

Since writing the above I have become aware that Bellucci asserts that during the pulverisation of water ozone is formed, and that the quantity of it is greatly increased if there are solid substances in the water. Now, ozone is a substance that oxidizes mercury, so, to determine as to whether or not the above results of mine were vitiated by its production, I made the following experiment. A quantity of finely-powdered glass was shaken up for a considerable time with a little boiled starch in water and potassic iodide in a phial, when it was seen that not the slightest coloration of the liquid had taken place. This result clearly showed that neither ozone nor nitrous acid in any sensible quantity had been produced.

The Oxidation of Iron in Alkaline Solutions.

The facts above stated and referred to, showing that the noble metals generally are readily oxidized in alkaline solutions, naturally leads one to infer that iron, as being more easily oxidized in a general way than these metals, should also oxidize in such a solution; but, as is well known to chemists, iron—metallic iron—is not supposed to oxidize in a solution of this nature, nor yet in strong saline solutions. Thus Berzelius long ago affirmed this, and later, in 1871,* Professor Grace Calvert reaffirmed it, and extended his experiments to show that alkaline carbonates act the same as the caustic alkalies in preventing oxidation. Again, and still later, Wagner, carrying on further researches on this matter, also states, as the result of this, that "iron will not rust in alkaline waters," evidently meaning that iron will not oxidize under these circumstances; for, if sesquioxide of iron is formed on the metal, the product is rust whether it exists in large or small quantity, whether it is visible or invisible to us.

It has been this apparent anomaly that induced me to investigate the matter as rigorously as I could for myself, when results were obtained that appear to show, and very conclusively, that the popular opinions regarding the non-oxidizement of iron in these solutions are erroneous.

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* *London Chemical News*, vol. 23, page 90.

1. Iron in metallic connection with copper in an aqueous solution of ammonia prevents this metal from going into solution and so communicating a blue colour to the liquid, as it would do if placed therein alone.

This clearly indicates that the affinities of iron for the oxygen present in that solution are greater than those of copper for this substance, and it as clearly indicates that the iron is being oxidized.

2. Iron in a strong solution of potassic cyanide or caustic potash is positive to iron in weak solutions of these salts respectively.

3. Iron paired with gold or platinum in any alkaline solution is positive thereto, and slowly becomes tarnished, while, if the negative metal has a much smaller surface than the other has, hydrogen gas is evolved therefrom for about half an hour.

These results make it very certain that when iron is electrically connected in a caustic solution with a metal negative to it, it becomes coated with a film of oxide of iron of a thickness sufficient to render it visible. It may be urged here, in defence of the old-established theory which I am combating, that these negative metals *initiate* the oxidation of the iron —that, in fact, there is as yet no proof given that iron when alone in alkaline liquids will oxidize, which is the question under consideration. To this I would answer that, to my way of thinking, chemical action (*e.g.*, oxidation) must in such cases as this always precede electrical action—that is, polarisation—as being its cause, and the only effect that should be ascribed to the negative metals (gold and platinum) is that of accelerating the chemical action that has been already initiated by the iron and the oxygen of the water and of the air present. And it is effected, as I conceive, in this way: The hydrogen that is set free from the water by the abstraction of its oxygen by the iron is not allowed to remain upon the surface of this metal to clog it, and so retard oxidation, but is set free at a distance away—*e.g.*, at the surface of the other metal—thus leaving the iron all bared to the exciting solution. But, whatever force there may be in this argument, the following results of experiments especially designed to settle this point appear to be decisive, and, besides, show the great intensity of the currents that are produced by iron in these kinds of solutions.

4. Iron in a solution of caustic potash is positive to iron in sulphuric or hydrochloric, also in nitric, acid. In the case where the last acid is used the positive element is rapidly enfilmed with ferric oxide.

5. Iron in solution of potash paired with platina or iron in nitric acid is able to deposit copper from its sulphate.

The interpolar connection between the two vessels containing the acid and alkaline solutions was a third vessel charged with a strong solution of salt, from which solution two pieces of filter-paper rose on either side, and, one entering the acid and the other the alkali, the connection was thus completed. The object of interposing the saline solution was to escape the interference of those electric currents that Faraday discovered to be generated by the combination of acids with alkalies.

These results (Nos. 4 and 5) demonstrate the fact that the affinity of iron for oxygen in alkaline solutions is even greater under these circumstances than its affinity for this substance in acid solutions, in which solutions, as we know, it is rapidly attacked and dissolved; and by so much they further demonstrate the fact that not only is a negative metal unnecessary to initiate the oxidizement of the iron, but that the tendency to oxidize on the part of this metal in alkaline solutions is so great that it can be very heavily handicapped without being overpowered.

It should be stated here that, generally, the stronger the acid used in these experiments—the greater their action on the iron—the more electro-positive the iron in the potash is.

6. The best iron wire that I can obtain, when allowed to have contact with an alkaline solution for a considerable time, may be seen to have acquired a darkish colour when it is compared side by side with a piece of the same wire that has not been thus immersed, showing that the metal is oxidized as unassisted by coupling it with another metal.

These results, taken as a whole, show very plainly that iron, like gold, platina, and silver, readily oxidizes in alkaline or strongly saline solutions in which it has hitherto been supposed to be unaffected; and they show besides that carbonic acid is not, as Professor Grace Calvert has stated, necessary for this action. In either of these solutions, in fact, it rapidly enfilms, but the film being insoluble therein, the process soon ceases, therefore the bulk of the iron is preserved, while the action may easily remain undetected. However, when the iron is polarised, either by itself or another metal, this oxidation goes on faster, and the evidences of it are quickly manifested.

Thus *all* the metals are alike in this—that each oxidizes in air and water; the only difference being as to the degree of the intensity of their affinities for oxygen under these circumstances, some, as iron and zinc, being able to decompose water to satisfy their affinities, while others, such as platina, gold, and silver, are unable to do this, so take all their oxygen from the air present in the solution surrounding them.

It will also be seen that, so far as these statements are accurate, they are favourable to the opinion I expressed over

twenty years ago,* that a great number of cases cited by Professor Becquerel and others of the polarisation of certain noble metals by the *mechanical* absorption of oxygen are really cases rather of polarisation by *chemical* absorption——that is to say, by *oxidation*.

To challenge investigation of the correctness of my assertions as to the general oxidation of *all* metals in solutions of this nature, and to give what I think may be a useful table, I append here one showing the relative affinity of twelve of the principal metals for oxygen in solutions of potash and sodic chloride respectively. Also, for comparison therewith, I append an extract of a table of mine from our Transactions showing the behaviour of these metals in potassic cyanide.

THE ELECTRO MOTIVE ORDER OF TWELVE METALS IN THREE DIFFERENT SOLUTIONS, FROM NEGATIVE DOWNWARD TO POSITIVE.

Potassic Hydrate.	Sodic Chloride.	Potassic Cyanide
Carbon (graphitic).	Carbon (graphitic).	Carbon (graphitic).
Platinum.	Platinum.	Platinum.
Gold.	Gold.	Iron
Mercury	Mercury.	Arsenic
Silver.	Silver	Antimony.
Copper.	Copper.	Mercury.
Iron.	Arsenic.	Lead
Lead.	Antimony.	Gold.
Tin.	Tin.	Silver.
Arsenic.	Lead.	Tin.
Antimony.	Iron.	Copper.
Zinc.	Zinc.	Zinc.

In potash, mercury is feebly positive to galena and strongly negative to chalcopyrites; while manganese binoxide is negative to the whole series in potash and potassic cyanide. In ammonia and sulphate of magnesia (for a conducting medium) platina paired with gold does not produce an electric current that I could detect.†

In concluding this section of my notes, I should not omit to remark upon the singularity of the results Nos. 4 and 5, where iron in alkaline solution is positive to itself in acid solutions. So singular indeed did this appear to me that I extended this investigation to include other metals in like solutions within its scope, to find that a number of metals, including platina, copper, lead, and zinc, gave like results to these. That metals should comport themselves in this manner is to me difficult to explain, and I would like to hear of the

* Trans. N.Z. Inst., vol. viii., p. 342.

† I should state here that in this solution gold was at first momentarily negative to the platina.

matter being taken up by some one who can throw light upon it. In the meantime I will state here that, to my mind, the fact that in the direct oxidation of the iron (by free oxygen) in the one cell there is no loss of energy in undoing a chemical combination, as there is in the other cell, may be sufficient explanation. There is, too, the fact that the oxygen in this acidified cell will soon be much diluted with hydrogen, or even driven off entirely. While the fact that hydrogen may stand for the negative pole must not be overlooked.

These experiments are well suited for a lecture-room, to demonstrate that it is the current of greatest intensity that dominates the galvanometer.

NOTE.—In regard to this matter I have just ascertained that iron in a strong potash solution that has been boiled (to drive out air) is also electro-positive to itself, as in the mineral acids; also that gold in potash solution is positive to itself in these acids, and even in chlorine; while silver in the alkaline solution is also positive to itself in warm or strong nitric acid. These facts appear to prove that in all my experiments in this research water is decomposed in the potash cell, the action only ceasing when the metal therein is so coated with an oxide as to be impervious to the solution. (4th April, 1897.)

ART. LXII.—*Notes on some Experiments with Chemical Manures.*

By W. F. WORLEY.

[Read before the Nelson Philosophical Society, 8th June, 1996.]

FOR several years I have carried on experiments with chemical manures in the kitchen garden. The results of most of these experiments have been highly satisfactory.

The following manures have been used: Lime, gypsum, bonedust, superphosphate, guano, nitrate of potash, sulphate of potash, sulphate of ammonia, chloride of ammonium, liquid ammonia, caustic potash, and sodium-chloride.

The best general results were obtained by the use of superphosphate (home made), nitrate of potash, and sulphate of ammonia. The crops grown were such as are usually found in a kitchen garden, and included potatoes, onions, peas, beans, cabbages, lettuces, radishes, celery, cauliflowers, rhubarb, turnips, carrots, parsnips, mustard, strawberries, currants, gooseberries, apples, peaches, plums, apricots, quinces, and tomatoes.

In the experiments, potatoes, onions, turnips, and radishes gave the best results, although all the above-mentioned were benefited by the application of suitable chemical manures. Watering cabbages with a dilute solution of sulphate of ammonia produced astonishing results, and the application of caustic potash and lime to the roots of apple-trees proved highly beneficial. As most of the crops were gathered in small quantities, as required for daily consumption, no exact record was kept of the amount of produce raised.

Rows of potatoes, peas, turnips, &c., however, were manured for about two-thirds of their length, the remaining third being left without manure The improved crop in the manured portion of the rows proved conclusively in most cases that, although somewhat costly, the manuring of them paid well. In some cases the unmanured portion produced nothing, the labour of digging and planting being quite unrewarded, whilst, on the other hand, there was a good crop on the manured part in return for the outlay in chemical manures. Being anxious to prove for the benefit of others the amount of advantage to be gained by the use of chemical manures, I conducted last year the following experiments .—

Arrangements were made with the proprietor of a piece of neglected used-up land for the ground to be treated with chemical manures. For this purpose the land was divided into four sections and planted with potatoes. An unproductive potato-crop had been taken from the land the previous year. No. 1 section was manured with bone-superphosphate and nitrate of potash, at a cost equalling £11 10s. per acre; No. 2 section with bone-superphosphate and sulphate of potash, at a cost of £9 15s. per acre; No. 3 section was manured with bone-superphosphate, sulphate of potash, and sulphate of ammonia, at a cost of £10 5s. per acre; and No. 4 section was left unmanured. The yield from the four sections was as follows: No. 1, at the rate of 19½ tons of potatoes per acre; No. 2, 15¾ tons; No. 3, 14¼ tons; No. 4, 11 tons.

The potatoes were sold in small quantities at varying prices, but the average price was equal to about £4 per ton. At this price No. 1 section would leave, after deducting the cost of manure, £66 10s. for labour, seed, and interest on capital; No. 2, £53 5s.; No. 3, £46 15s.; No. 4, £44 (there being no deduction for manure in the latter case). These comparisons are not, however, strictly accurate, since the potatoes on the manured sections, owing to the stimulating effect of the manure, matured early, and consequently realised a better price than those from the unmanured section; and, further, at least 25 per cent. of the manure used on sections 1, 2, and 3 would be left in the soil, available for a second crop.

If the potatoes had only realised £2 per ton, then sections 2 and 3 would have shown a loss by comparison with the unmanured section. On section 2 there would have been an apparent loss of 5s., and on section 3 a loss of £2 15s. Theoretically, section 3 ought to have come out better than section 2. The manure used on section 3 was the same as that used on section 2, *plus* sulphate of ammonia, which ought still further to have improved the crop. As section 3 was close to the hillside, probably this fact had something to do with the results. Leaving out of calculation No. 3, whilst the use of chemical manures on section 2 showed an apparent loss of 5s. per acre, section 1, even with potatoes at £2 a ton, would show a profit of £5 10s. per acre—that is to say, an expenditure of £11 10s. per acre in chemical manures produced 8½ tons more potatoes than the unmanured section, or, in other words, an outlay of £11 10s. produced an increase of £17. But at £4 per ton, which is a reasonable price, an expenditure of £11 10s. per acre would result in thirty-seven pounds' worth of extra produce, or a nett increase of £26 10s.

These results, though striking, are, I am sure, quite in harmony with the results that I have obtained on my own ground during the last ten or twelve years, and prove conclusively that chemical manures will pay—on some soils at any rate—if the right kinds are used in the right way. The success obtained in these experiments is largely due to the care exercised in the selection of the chemical manures. The superphosphate was made by myself from locally-prepared bone-dust which had been previously analysed to test its purity, and was used quite fresh before it had had time to deteriorate. The nitrate of potash, sulphate of potash, and sulphate of ammonia were also proved to be of good quality before being used. The potatoes were planted in drills, and the chemical manure, well mixed, was scattered around the sets before covering with earth.

—	No. 1.	No. 2.	No. 3.	No. 4.
Yield of potatoes per acre ..	19½ tons	15¾ tons	14¼ tons	11 tons.
Value of potatoes at £4 per ton	£78 0s.	£63 0s.	£57 0s.	£44 0s.
Cost of manure per acre ..	11 10	9 15	10 5	..
Balance left for seed, labour, and interest	£66 10s.	£53 5s.	£46 15s.	£44 0s.

NEW ZEALAND INSTITUTE

NEW ZEALAND INSTITUTE.

TWENTY-EIGHTH ANNUAL REPORT.

THE Board held meetings during the past year on the following dates 6th August and 17th December, 1895; 14th February and 26th March, 1896.

The retiring members from the Board, in conformity with the Act, were Mr. W. T. L. Travers and Mr. E Tregear, and there was a vacancy caused by the death of the late Hon. W. B. D. Mantell; and His Excellency the Governor was pleased to reappoint Mr. Travers and Mr. Tregear, and to appoint Mr. J. Young to fill the place of the late Mr. Mantell. The branch societies, in accordance with clause 7 of the Act, elected the following gentlemen to represent them on the Board for the year, viz.: Major-General Schaw, Mr. J. McKerrow, and Mr S. Percy Smith.

A vacancy in the roll of honorary members having occurred owing to the death of Professor Huxley, the Board, on the recommendation of the incorporated societies, elected Mr. William Mitten, F.L S, the distinguished cryptogamist, who contributed so largely to the flora of New Zealand, to fill the vacancy.

Another vacancy has occurred in the honorary members' roll, by the death of the late Professor Riley, the eminent entomologist, of the Department of Agriculture at Washington.

The Institute has lost by death two distinguished members, and the Board passed the following resolutions in acknowledgment of the services they had rendered:—

1. William Christopher Richmond: "That the Board of Governors, acting on behalf of the members of the New Zealand Institute, who represent scientific research in this colony, desire to place on record their appreciation of the brilliant talents of the late Mr. Justice Richmond, and of the great benefits the colony has received from his untiring efforts to diffuse sound philosophy by his numerous writings and lectures, and particularly to acknowledge the powerful aid which he gave towards the foundation of this Institute."

2. Walter Baldock Durant Mantell: "That the Governors of the Institute express their sense of the great loss science has sustained through the death of their late colleague

W. B. D. Mantell. Throughout a long career of over fifty-five years he did noble service to New Zealand as a public official, a politician, and as a scientific investigator, and was an especially active initiator of the New Zealand Institute, in the control and management of which he took an active part since its foundation. His name will always be associated with the discovery and collection of the remains of the Moa-birds, which formed so unique a feature in the fauna of these islands."

The members now on the roll of the Institute are: Honorary members, 29; Auckland Institute, 172; Hawke's Bay Philosophical Society, 80; Wellington Philosophical Society, 143; Philosophical Institute of Canterbury, 70; Nelson Philosophical Society, 24; Otago Institute, 91; Westland Institute, 62: making a total of 671.

The volumes of Transactions now on hand are: Vol. I. (second edition), 240; Vol. V., 18; Vol. VI., 20; Vol. VII., 103; Vol. IX., 105; Vol. X., 138; Vol. XI., 29; Vol. XII., 36; Vol. XIII., 34; Vol. XIV., 58; Vol. XV., 168; Vol. XVI., 168; Vol. XVII., 170; Vol. XVIII., 143; Vol. XIX., 158; Vol. XX., 160; Vol. XXI., 91; Vol. XXII., 92; Vol. XXIII., 168; Vol. XXIV., 173; Vol. XXV., 173; Vol. XXVI., 178; Vol. XXVII., 180; Vol. XXVIII., not yet fully distributed.

This year's volume (XXVIII.), just published, contains seventy-four articles, together with addresses and abstracts which appear in the Proceedings. The work consists of 808 pages and 37 plates, besides numerous illustrations inserted in the letterpress. The following gives a comparison of the contents of the present volume with that of last year:—

	1896. Pages.	1895. Pages.
Miscellaneous	204	154
Zoology	286	298
Botany	134	154
Geology	64	30
Chemistry	28	—
Proceedings	47	58
Appendix	45	48
	808	742

The cost of printing Vol. XXVII. was £441 16s. for 742 pages, and that for the present volume (XXVIII.) £485 6s. 2d. for 808 pages.

The first part of Vol. I. of the standard work on Maori art, which is being written for the Board by Mr. A. Hamilton, is now in the press. It is devoted to Maori canoes, and is illustrated by process-block printings from photographs.

The Honorary Treasurer's statement of accounts shows that there is a balance in hand in the current account of £24 13s. 2d.

The amount appropriated for the publication of memoirs and postponed papers (according to resolution) is now £818 17s. 10d.

Approved by Board. JAMES HECTOR,
Manager.

GLASGOW,
Chairman.

21st July, 1896.

NEW ZEALAND INSTITUTE ACCOUNTS FOR 1895–96.

Receipts.	£	s.	d.	*Expenditure.*	£	s.	d.
Balance in hand, 12th August, 1895.. ..	58	6	8	Outstanding lithographic account for Vol. XXVII. ..	30	16	3
Parliamentary grant for 1895-96	500	0	0	Printing and publishing Vol. XXVIII. ..	485	6	2
Contribution from Wellington Philosophical Society	18	0	6	Expense of library, cataloguing, &c.	15	19	10
Sale of volume.. .	1	1	0	Publication of work on Maori art	7	19	9
				Foreign postage, stationery, and miscellaneous	12	13	0
				Balance in hand ..	24	13	2
	£577	8	2		£577	8	2

WM THOS. LOCKE TRAVERS,
Honorary Treasurer.

21st July, 1896.

PROCEEDINGS

WELLINGTON PHILOSOPHICAL SOCIETY.

First Meeting: *8th July, 1896.*

Mr W. T. L Travers, F.L S., President, in the chair.

New Member.—Mr. Frank Maxwell Lockie.

The President delivered his opening address, Antarctic Explorations, Rontgen Rays, and the Discovery of Argon being the subjects of the address. (*Transactions*, p. 111.)

Major General Schaw was sure he spoke the feelings of all present when he proposed that the thanks of the meeting be given to the President for his address, which had given so much information in so clear and pleasing a way. Mr. Travers had alluded to the speaker's paper as to the need of pendulum experiments being made further south He had also alluded to Mr. Proctor's theory that the peculiarly low atmospheric pressure towards the South Pole was caused by the centre of gravity of the earth being south of the equator. All the facts hitherto ascertained by pendulum experiments showed that, on the contrary, the centre of gravity of the earth was north of the equator He was very glad that the President had again drawn attention to the necessity of making exhaustive pendulum experiments as near the South Pole as possible.

Sir James Hector had much pleasure in seconding the vote of thanks to the President for the valuable and well-rendered *résumé* he had given of the most prominent scientific discoveries made during the past year. With respect to Antarctic Exploration, he fully agreed with the views of the President. As to the interior of Antarctica, he had always held the opinion that the snowfall must decrease towards the interior and round the pole after crossing the ice-cliff border, across which moisture could not penetrate far without being deposited, as the average maximum temperature was below 32°. His views had often been expressed to the Society that it was rather a disgrace that no earnest attempt had been yet made to explore such a large and totally unknown area of the earth's surface.

Mr. Tregear said it was a pleasure to the younger members of the Society to know that Mr. Travers was once more in the chair, and still active and doing good work He complimented the President for his able address.

Mr. Harding said they had heard a most interesting address. It was a curious thing that Argon was so nearly discovered nearly a hundred years ago by an old chemist, and that forty years ago they were on the brink of discovering the Röntgen rays. He was glad to hear that coloured photographs could now be obtained.

Mr. Hustwick said it was Dr. Priestley who so nearly discovered Argon.

Mr. Travers returned thanks for the manner in which his address had been received.

SECOND MEETING: *22nd July, 1896.*

Mr. W. T. L. Travers, F.L.S., President, in the chair.

New Members.—Mr. F. E. Clarke and Mr. John Young.

Papers.—1. "On Polynesian Migrations," 1st section—chapters I., II., and III., by Mr. Joshua Rutland; communicated by Mr. E. Tregear. (*Transactions*, p. 1.)

Sir James Hector was glad to hear this paper read. It was most interesting, and afforded a large amount of information on all branches of science. Of course, until Mr. Tregear had read the whole of the paper it was not possible to have any lengthy discussion on the subjects brought forward. The question as to what plants might be considered indigenous to this country was an important one, and perhaps Mr. Kirk, who was preparing a new work on the botany of New Zealand, would be prepared to make known his views in the matter. He himself thought that all plants found flourishing by the first arrivals should be looked upon as indigenous.

Mr. Maskell said Mr. Rutland had written an able paper entitled "The Fall of the Leaf," and he thought any paper from this gentleman would be sure to be interesting.

Sir W. Buller, in reference to what Sir James Hector had said, expressed a hope that Mr. Kirk would include in his forthcoming Flora of New Zealand descriptions of all the plants found in this country by the first European discoverers, whether actually indigenous or introduced by the Maoris when they came to New Zealand, and whether these plants had become presumably extinct or not. The rule in zoology was to include in the indigenous fauna all animals that had found their own way to the country as distinguished from those introduced by man—for example, in his "History of the Birds of New Zealand" he had included all stragglers from Australia and elsewhere, without considering whether the arrival was ancient or recent. Any bird winging its own way across the ocean to this land, from whatever cause, would by the accepted rule be entitled to a place in our own fauna.

Mr. Kirk said botanists were a little more particular than ornithologists. He could not include all plants found here as indigenous. If he did there would be no end to the collection. The rule was that all plants that had become naturalised should be described, although they might have been introduced by Europeans. Among the plants that would cause some difficulty he instanced a species of *Cordyline*, which had never been known to have flowered in New Zealand, and which might turn out to be a plant that flowers in a warmer climate. There were also several other plants that would require to be added to the list of naturalised species.

Sir James Hector would like to add that the plant referred to by Mr. Kirk was the curious Ti-tawhiti,* supposed to be a *Cordyline*, and which, as stated, never flowered in New Zealand. It was grown by the natives in the Taranaki district, and had large bunches of rather thick green leaves for a palm-lily, with long intervals of stem. These were tightly ligatured by the Maoris, and pegged down, when they developed a large

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* The *Ti* from a distance.

amount of sweet starchy matter, which was used as food. When in Sydney Botanic Gardens, the Director, Mr. C. Moore, had shown him a thicket of what seemed to be the same *Cordyline*, which he said he (Sir J. Hector) should know, as it came from New Zealand, and he (Mr Moore) informed him that it had a blue flower. He (Sir James) had brought plants and suckers to New Zealand, some of which were in the late Mr. Mantell's garden, and others should now be in the Wellington Botanic Gardens One most interesting point in the paper just read was raised by the statement that Cook had found the natives possessed the tapa-cloth plant, and that he had seen it growing. Its native name, "Aute," was included in Maori vocabularies, but the plant seemed to have disappeared from Maori settlements, though now again common under cultivation in gardens. Yet this plant, interesting on account of its economic uses and its distribution among the Pacific Islands, was not mentioned in the "New Zealand Flora" either as an introduced or native plant There were many other plants in the same anomalous position, and they raised a very curious question that might greatly affect certain views as to the geographical distribution of plants and the migration of the human race among the Pacific Islands

Sir W Buller said the Ti tawhiti was a narrow leafed *Cordyline*, and very scarce. He believed he had once seen the flower, which was of a pale-blue colour The Maoris valued it because of its edible qualities

Mr Harding said Mr Colenso, of Napier, had a rare plant of this kind in his garden He understood it was *Cordyline edulis*, and the sole representative of the species.

Mr. Travers said there was a very similar plant growing in a garden near Plimmer's Steps, in Wellington, but he understood it was from Queensland.

Mr. Tregear said the chief value in this paper was the fact that it was so suggestive, and turned our attention to so many interesting facts It was a sort of text book to several branches of science. There were many statements that he could hardly agree with. The occurrence of many of the plants named was, he thought, purely accidental

2. "On Formol for preserving Natural History Specimens," by S. H. Drew, of Wanganui; communicated by Sir W Buller (*Transactions*, p. 288)

Sir J. Hector considered Formol very good for preserving specimens, and in most respects better than spirits, but care must be taken regarding its strength.

Mr. Maskell said, in the event of an antarctic expedition formol would be very generally used, but it must be dealt with carefully, and in most cases a weak solution used, so as to preserve the delicate colours of invertebrates.

4. "Natural History Notes," by S. H. Drew, of Wanganui Museum: (1) On *Orthagoriscus mola* (sun-fish); (2) on *Botaurus pœciloptilus* (bittern); (3) on *Carpophaga novæ-zealandiæ* (wood-pigeon); (4) on *Cnemiornis* (extinct goose), (5) on moa remains found at Wanganui (*Transactions*, p. 284.)

Third Meeting: *12th August, 1896.*

Mr. W. T. L. Travers, President, in the chair.

Before the business of the meeting commenced feeling references were made by the Chairman to the deaths of the Hon. Robert Pharazyn, M.L.C., and Mr. Charles Rooking Carter. The former was secretary of the Society twenty-five years ago, and remained an active member up to the time of his death, contributing many papers. Mr. Carter, although not a member of the Society, presented to the New Zealand Institute books on New Zealand to the value of £600 or £700, and the collection was the largest and finest in the colony, many of the books being now out of print

Sir James Hector called attention to the fact that Mr. Carter had also made provision for an observatory in Wellington; and it was proposed by the President, and seconded by Sir James Hector and carried, that a record should be made in the minutes of the Society expressing the deep regret felt by the members for the loss of these two gentlemen.

Paper.—"On the Brunner Mine Disaster," by Sir James Hector.

Before proceeding with his paper, Sir James Hector asked permission to invite Mr Bishop, the manager of the Brunner Mine, who was present, to say a few words on the subject, as Mr. Bishop was obliged to leave the meeting early to catch a steamer south, and he could not wait until the paper was read.

Permission having been granted, Mr. Bishop said he regretted that he had to leave in half an hour, and would not be present for the conclusion of the paper, which promised to be most interesting and instructive. He was, however, glad to be allowed an opportunity of saying that he had read the report of the Commissioners, and thought they had arrived at a just conclusion as to the cause of the lamentable disaster He agreed with the suggestions made in the report, and felt sure that every mine-manager and miner in the country would loyally carry out any legal provisions that were made to secure the safety of the working miner.

Abstract.

Sir James Hector, in the course of his lecture, described the geological structure of the West Coast districts, and went on to say that Mr. Brunner, in 1846, was the discoverer of the Brunner Mine, finding a seam of coal at the river-level. In 1868 the first attempt was made to open the mine, but as recently as 1886 there was only a moderate extent of excavation. After giving particulars of the present mode of working the mine, and the incidents of the explosion and the recovery of the miners' bodies, the lecturer stated, as evidence of the terrific effects of the explosion, that the smoke from it came to the outlet against the draught through the workings; that the coal was charred over a very large area to a depth of 4in.; and that the body of one man was driven up an incline of 300ft. and smashed up against a wall of coal. At the top of the incline—at the motor-house—a man was smashed to pulp and a boy stripped of every particle of his clothing without being burned in the slightest degree. The explosion was, it was conclusively proved, not a fire-damp one, but an imperfect explosion of coal-gas, leaving white damp, the most deadly of all damps, and ½ per cent. of which would be fatal if continuously breathed. The cause of the explosion was proved to be due to a miner having put in a big charge

of blasting-powder in an improper manner, so that instead of breaking down the coal it blew out like a cannon-shot, with the result that the tremendous explosion took place. All the evidence went to show that the noxious gas produced arose from imperfect combustion, and was carbonic oxide or white damp, and that the foolish conduct of the person who fired the shot had been the cause of the disaster.

Mr. Maskell considered the meeting greatly indebted to Sir James Hector for his clear and interesting explanation of the cause of the great disaster. It was satisfactory to know that the Commissioners had agreed as to the cause of the explosion, and they deserved thanks for their careful work.

Mr. Harding had always wondered how it was that gunpowder could be safely exploded in so confined a space as a coal-mine.

Mr. Tanner was glad to know what a blown-out shot was. He should have thought that special men only would have been employed in preparing for these dangerous explosions.

General Schaw said that to him the most interesting part was the general description of the New Zealand coal-formations. One never could be quite sure, in making shot-holes, that they would not sometimes blow out. To fire a blast in a coal-mine was, he considered, an awfully risky thing. He hoped to see some other method adopted for bringing down the coal.

Sir James Hector, in reply, said no gunpowder had been used in the Kaitangata coal-mine for some years; a flameless explosive was used, and it had proved most successful. He thought the use of gunpowder would be done away with altogether. He hoped to see hydraulic pressure used to bring down the coal, and this would be quite safe. Since the Brunner explosion, the firing was done only by skilled men, as suggested by Mr. Tanner. He described how the holes were bored and charged.

The following exhibits were on view: (1.) Locusts from South Africa, presented by Mr. W. P. Cohen. (2.) Fine specimens of the vegetable caterpillar, collected and presented by Mr. C. Fitton. (3.) Petrel (*Œstrelata cervicalis*), from Kermadec Islands, presented by Sir W. Buller. (4.) Harrier (*Circus gouldi*). (5.) Globe-fish (*Tetrodon gillbanksii*), presented by Mr. F. E. Clarke, New Plymouth.

Fourth Meeting: *26th August, 1896.*

Mr. W. T. L. Travers, President, in the chair.

Papers.—1. "A Phase of Hypnotism," by E. Tregear, F.R.G.S. (*Transactions*, p. 83.)

General Schaw said the condition mentioned by Mr. Tregear called "lata" was no doubt similar to hypnotism or mesmerism. He had witnessed exhibitions of this power, and it was very similar to that described in the paper. It was an interesting subject, but he was not sure that any real benefit had come from it.

Sir James Hector thought this power was known among the Maoris; probably "lata" was the same as "rata," which he thought meant "tame, or friendly," and also "a friend, or adviser." When travelling with Sir Grey among the Maoris he was always addressed as "Rata-o-te-Kawana."

Mr. Harding said the curious part of Mr. Tregear's account was that these subjects should be influenced by any one; it was unlike mesmerism in this particular.

Mr. Travers gave instances of the hypnotic condition, which were very extraordinary. His impression was that a similar influence was exercised by the *tohungas* upon the Maoris. He thought that the general verdict was that hypnotism was a thing rather to be avoided than used.

Mr Tregear, in reply, said the difference between mesmerism and hypnotism was that in the former the person was under the influence of a stronger will. This was only one stage, but when a person was under hypnotic influence he went through three stages, and, being under the influence of suggestion alone, was at the mercy of everybody who chose to make a suggestion. It would be interesting to find that this power was known to the Maoris.

2. "On Two New Globe-fish" (*Tetrodon gillbanksii* and *Tetrodon cheesemanii*), by F. E. Clarke. (*Transactions*, p. 243.)

3. "Note on a Specimen of *Lophotes*, sp.(?)," by F. E. Clarke. Specimens exhibited. (*Transactions*, p. 251.)

Sir James Hector said the *Plectognathi* form an interesting group of fishes having some affinity to the sharks and rays, but having some solid bones, though no ribs. They are so named from the curious twisted conformation of the jaws There are three groups—the globe-fish, the sun-fish (which is enormously large), and the leather-jackets. Globe-fish live on Crustacea, and have a habit of distending their bodies with air and expelling it forcibly with a hoarse noise. They are not edible, and are sometimes very poisonous if the gall or any of the viscera remain in the fish when cooked. Pison said the symptoms were impaired sensibility of the tongue, and rigid cramps, cold sweat, and death. Similar, though modified, symptoms are caused by the prick of the spines. Father Dutertre has described how this fish approaches the bait (a crab) with caution, tastes it, retires, returns, and swallows greedily, then blows its body up like a balloon, rears like a turkey-cock, wheels round and round, and becomes furious. It then has recourse to stratagem, lowers its spines, and allows itself to be drawn in, but the moment an attempt is made to secure it the fish suddenly resumes its dangerous activity. The *Tetrodon* is much smaller than the *Diodon*. It also inflates itself when tickled, and the boys on the wharves make a cruel sport by bursting them with a loud report. One species is very common in the Nile, spreads over the country during the inundations, and when decomposing becomes most dangerous The Mussulmans inflate these fish, dry them, and then hang them in bunches from the pinnacles of the minarets of their mosques. The Japanese hold one species in high estimation as food, but they clean and prepare them with the greatest care; notwithstanding, the epicures often fall victims, and die in two hours. When not well cleaned they are so deadly as to be used by suicides. There is a plant named *Rex amarous*, which is said to be an antidote to the poison, but *anise* greatly increases its virulence. One species has electric organs, and gives off smart shocks when touched.

4. "On the Chemical Position of Cyanogen, and its Inability to combine directly with Gold and Silver," by W. Skey: an abstract was read by Sir J. Hector. (*Transactions* p. 574.)

Mr. Hustwick said it was not generally accepted that cyanogen alone was a solvent for gold, and that, though the Cassel Company claimed the sole use of cyanogen and its compounds, they virtually abandoned the claim to cyanogen alone, because their specification required it to be used in the presence of an alkali.

FIFTH MEETING: *9th September, 1896.*

Mr. R. C. Harding, Vice-president, in the chair.

Papers.—1. "Australian Weather-charts and New Zealand Storms," with diagrams and charts, by Major-General Schaw, C.B., R.E. (*Transactions*, p. 61.)

Sir J. Hector said General Schaw deserved thanks for the heavy task he had undertaken in searching through the hundreds of weather-charts that were filed in this office. Without a much larger meteorological staff it was impossible to turn them to proper account. They were the result of an expenditure contributed by all the colonies, but New Zealand contributed only a small share. The information was exchanged by telegraph daily, and each of the colonies prepared a weather-chart similar to those exhibited, which were the Queensland charts. The speaker explained how, about fifteen years ago, after several conferences, he had prepared diagrams showing all the usual forms of isobars —twenty for Australia and twenty-four for New Zealand. These were numbered, and the numbers for each day were interchanged by cable. Stereotyped blocks of these diagrams had been supplied to all the principal newspapers, and for some time they were used, but now they were not, so that the New Zealand public no longer got any benefit from the daily telegrams, and the old-fashioned and obsolete method of weather-warnings had been resorted to by the newspapers. In some respects he differed from the General's views. Although it was convenient to treat all wind variations as closed curves, there was reason for believing that this was only true for the tropical circular storms, and to a modified extent for those in the Northern Hemisphere. In our south temperate latitudes the weather-changes were most frequently curves open to the south—that was, without easterly winds. The pressure-changes advanced eastward in great waves that died out as they approached the great sub-tropical areas of high pressure. In the advancing or east side of the wave the wind was north-west, and the barometer fell rapidly, while on the following or western side the wind was south-west and the barometer rose rapidly. The speaker illustrated this by the curves of the self-registering barometer, for the month of February, 1895, at Wellington, Dunedin, and on board the "Hinemoa" when at the southern islands. The curves showed that four great dips took place during the month, and that these intervened between north-west and south-west winds, there being no indication of the closing-in of the curves by easterly winds in the far south. Such intrumental curves were more trustworthy than isobars, which were necessarily to a large extent conjectural, and were therefore more useful for tracing the weather-changes. He thought we must not cling too rigidly to the theory of circular movements of the atmosphere in southern latitudes.

Mr. Hudson said the members must feel indebted to both General Schaw and Sir James Hector for the valuable information they had given on this most interesting subject of weather forecasting.

2. "On Two New Species of Lepidoptera" (*Orthosia margarita*, n. sp., and *Asaphodes siris*, n. sp.), by E. F. Hawthorne. Specimens exhibited. (*Transactions*, p. 282.)

Sixth Meeting: *23rd September, 1896.*

Mr. W. T. L. Travers, F.L.S., President, in the chair.

Papers.—1. "Polynesian Migrations" (Chapter IV., Agriculture; Chapter V., Domestic Animals), by Joshua Rutland; communicated by E. Tregear, F.R.G.S. (*Transactions*, p. 20.)

Mr. Richardson did not agree that the dog was not introduced as a domestic animal because it was allowed to go wild. It was well known that domestic dogs often went wild, also horses and cattle.

Mr Kirk said the fungus mentioned was similar to one eaten by people in South America. It grew on the beech-tree as large woody masses One of these, on the silver-beech in Preservation Inlet, was the most nutritious known; and another specimen in Tasmania was probably the same as that in New Zealand, but not the same as that of South America.

Mr. Maskell said, no doubt this paper was very interesting. The facts seemed correct, but the deductions were not strictly logical. The point concerning the dog was one instance. Of course, it was well known that the common cat was often wild. He himself had seen in the South Sea Islands ordinary fowls in a wild state in the bush; and to say that they could not have been introduced by others because they were wild was, he thought, incorrect And because the bark-cloth (*tapa*) was used in Madagascar and other places, that therefore it was impossible for it not to have come from some great central place, was also unsound reasoning.

Mr. Hudson mentioned that, in connection with the knowledge of agriculture in ancient Egypt, some very interesting remarks were contained in Mr. Peck's new astronomical handbook. The author, in tracing the origin and meanings of the names of the zodiacal constellations, considered that they could only refer to certain agricultural operations performed by a race of people living in the Nile Valley about fifteen thousand years ago. This remote period was arrived at by taking into account the effect of the precession of the equinoxes on the apparent positions of the constellations since they were named.

Mr. McLeod was in doubt as to whether the writer of the paper had given sufficient consideration to the hypothesis that similar climatic and other conditions prevailing for centuries in the various regions touched upon would tend to produce parallel results.

General Schaw thought the paper was full of interesting facts, but he agreed with Mr. Maskell in thinking that the deductions from them were doubtful, and the general line of argument one in which he could not concur. He felt, however, that to attempt to criticise a portion of a paper was unfair. He himself had seen no reason to doubt the general history of the human race given in the Bible. He had no belief in ages of agriculture or ages of pastoral life, but that rather, from very early ages, men had followed various lines of life according to their tastes and surroundings, just as they do now.

Mr. Travers said, what the writer of the paper said regarding the dog was that, had they possessed it in domestication they would not have allowed it to go entirely wild. As to the introduction of the kumara into New Zealand, the natives had deliberated over this, and had concluded that each of the canoes arriving here brought the kumara as part of their supply, not one canoe only. This fact was in Mr. White's History of New Zealand. The fungus referred to was used in Russia, but did not appear to be valued as food by us. The kitchen-middens, he said, owed their

origin to those who visited the coast for food, and not to those living close by. He mentioned the Digger Indians, and their mode of life. He did not think the writer of the paper wished to introduce the question of the origin of life.

Mr. Tregear said he hoped the remaining chapters of the paper would be read. It was a useful paper, inasmuch as it might induce others to write on these subjects, and afford further information. There were many things in the paper that he could not agree with, but he considered it most valuable and suggestive. The writer did not, he thought, intend to introduce any question as to the origin of life.

2. "On Kerns and Serifs"—two old and curious words much used by English printers—by R. Coupland Harding. (*Transactions*, p. 95.)

Mr. Tregear said Mr. Harding's paper was most interesting. He quite agreed with him in saying that Mr. Murray, in preparing his new dictionary, had no right to leave out, as he was doing, certain words which he considered not proper to appear. It quite spoilt the work for the purpose of reference.

Mr. G. V. Hudson exhibited a splendid set of drawings of New Zealand *Lepidoptera* which he had prepared to illustrate his new work on the subject. The drawings were greatly admired.

Seventh Meeting: *7th October, 1896.*

Mr. W. T. L. Travers, F.L.S., President, in the chair.

Papers.—1. "Further results, showing that Free Cyanogen does not dissolve or even attack Gold," by W. Skey. (*Transactions*, p. 576.)

Sir J. Hector said that, for delicate experiments such as these researches required, Mr. Skey laboured under great difficulties, as the Laboratory was not properly equipped for such investigations. The conclusions arrived at were very important.

General Schaw pointed out that the gold thrown down as described was considered by the author to be in an allotropic state, and its behaviour with cyanogen might be very different from gold in the ordinary state.

Sir J. Hector said the behaviour of gold finely intermixed with cellulose might be very different from free gold. He would like to hear what Mr. J. S. Maclaurin had to say on that subject, on which he had brought very high chemical training to bear.

Mr. Travers said the whole matter turned on the employment of the cyanide process for the extraction of ordinary gold. If the gold operated on by Mr. Skey was not in its common form the results would not have a practical bearing.

2. "Notes on Moa-bones in Gold-drift" (collected by Mr. Lukin in the Sherry River district, Nelson), by Sir J Hector.

Sir J. Hector said, from Mr. Lukin's notes it appeared that these bones were found at the base of a Recent river-gravel deposit 20ft. thick resting

on the denuded surface of a marlstone formation of Miocene age. The gravel was being worked by hydraulic sluicing, and the gold was chiefly found in the bottom layer, which also contained the bones. These were all in rolled or water-worn fragments, and, as they had a honeycombed structure, a considerable amount of gold had lodged in them, which the miners obtained by crushing and washing the bones. From his knowledge of the locality, he believed the gravel to be quite recent, and formed long after the lignite and auriferous gravels of Pleistocene age which occurred in the same district. The bones were probably of the species *Dinornis robustus*, and were as follow: 3 dorsal vertebræ; 1 sacrum, 2 fragments of tibias, of different birds; 1 fibula of left side; 1 ischium and acetabulum—left side; 1 ischium, right side; 1 ischium, right side of a smaller bird; 8 ribs, 1 fragment of sternum: so that probably several birds are represented in the collection.

Mr Travers said he knew the locality. It yielded rich auriferous gravels that had been worked for the last thirty-five or forty years, but under great difficulties, owing to the absence of water, without incurring a large expenditure Now he believed the property had changed hands, and £70,000 was to be spent in developing the field.

Mr. Hudson asked if moas were supposed to have had external rudimentary wings He could not understand why birds should lose their wings because they did not require the use of them.

Sir James Hector replied that some forms of the moa had very small rudiments of a wing. Disuse led to the diversion of nourishment from any organ to other parts of the body that were used in excess. No doubt the development of the ponderous legs of the moa was effected at the expense of the blood supply diverted from the wings The interesting point was that in New Zealand there were not only many kinds of true *Struthionidæ*, which is a family in which the breast muscles for flight were not developed, but there were also many other families of birds that elsewhere had power of flight, but yet in New Zealand had lost that power and the mechanism required for it.

3. "Notes on the Vegetable Caterpillar," with specimens, by Mr. Charles Fitton; communicated by G. V. Hudson.

The author contributed a number of fine specimens of the dried caterpillars, and also a number of live ones, with notes as to their mode of occurrence; but these all proved to be of species that were well known not to be true vegetable caterpillars, the moth or imago state of which had still to be discovered.

Mr. Maskell wished to say only a few words, not about the specimens or the notes, but by way of a mild protest against the manner in which this subject, originally brought forward by him in 1894, had been ignored in favour of the discussions so frequently taking place as to this caterpillar itself. In 1894 he incidentally brought in this insect as an illustration, and only an illustration, of what he, and, as he gathered at the time, Sir J. Hector, Mr. Kirk, and Mr. Hudson also, considered a most important question—the assistance given to tree- and fruit-growers by certain fungoid organisms which killed injurious insects. That question had since been taken up very seriously in many other countries, but in New Zealand, because Sir W. Buller chose to raise what he (Mr. Maskell) said was a perfectly trivial and unimportant issue, the really important question had been obscured, and, although they had had this vegetable caterpillar constantly brought forward, nobody seemed to care for anything but the merest trivialities in connection with it. It was necessary to point out, in the interests of tree-growers in the colony, that

the really important part of the thing was not the caterpillar, but the fungus which killed it, and he was sorry that, with our Agricultural Department, and the Lincoln Agricultural College, and professors of biology all over the country, nobody seemed inclined to take up this economic side of the question.

Mr. Tanner said it was a pity that the true species to which the vegetable caterpillar belonged could not be discovered. He had lately taken a great interest in these boring insects, as they had commenced to attack his trees.

Mr. Hudson said that the real point to be determined in connection with the subject of the vegetable caterpillar was the discovery of the true species of *Lepidoptera* to which it belonged. He was perfectly certain that it was not *Hepialus virescens*, whose larva was a tree-borer, but it would probably prove to be one of the species of the genus *Porina*, the larvæ of which were subterranean With regard to Mr. Maskell's regret that so much attention had been given to this insect by the members of the Society, to the exclusion of the economic study of the various fungi which destroyed insect-pests, he thought the investigation of this caterpillar was a matter of great scientific interest, and was therefore a most suitable subject for the Society—far more so, in fact, than mere questions of economic entomology and fruit-culture.

Mr. T. Kirk agreed with Mr. Maskell that the economic side of the question did not receive sufficient attention. What was required really was an expert vegetable pathologist, who could devote his whole time to such work as this. Credit was due to those who had done so much already in this branch of science, but they had no time to go specially into the matter. He was sorry credit had not been given to Mr. Hamilton, who had first discovered the little beetle *Vedalia*, which had been of so much use in destroying the fluted scale. Was Mr. Hudson quite sure that *Hepialus virescens* was the larva that bored? There was a great deal to be learnt regarding the life-history of these borers. The green moth bored into the hardest timber—the puriri.

Mr. Tregear said that Mr. Tanner was like a great many others in this country—they only took an interest in such matters when it affected them personally. It was a pity that farmers and those interested did not come forward and assist those who were devoting their time to this valuable work of investigation.

Mr. Maskell, in answer to Mr. Kirk, said the appointment of a vegetable pathologist was just the very thing he had been advocating, and it was what other countries had done. As regarded the beetle usually called *Vedalia*, and its destruction of what Mr. Kirk termed the "fluted scale," he differed entirely from Mr. Kirk. Whether Mr. Hamilton ever saw *Vedalia* or not, before Mr. Koebele came he certainly never said anything about it, and the credit was justly and rightly given in every country in the world to Mr. Koebele, the man who, finding *Vedalia*, first in Australia and secondly in New Zealand, knew how to make practical use of the discovery, and went practically to work with it. It was he, and he only, who cleared California and other countries from *Icerya*, and he, and he only, deserved the credit.

Mr. Travers thought the moth that was converted into the vegetable caterpillar took the fungi while feeding. There were several species that were attacked by the fungi. He called attention to the splendid collection of vegetable caterpillars on the table that had been secured and presented to the Museum by Mr. Fitton.

Mr. Hudson, in answer to a question by Mr. Kirk, said that the larva of *Hepialus virescens* fed on many forest-trees. He had found them in *Aristotelia racemosa*, *Leptospermum ericoides*, and several other trees the names of which he was unacquainted with.

Eighth Meeting: *11th November, 1896.*

Mr. W. T. L. Travers, President, in the chair.

Major-General Schaw was appointed by the Society to vote in the election of Governors of the New Zealand Institute, in conformity with the Act.

The following gentlemen were nominated as honorary members of the New Zealand Institute, there being two vacancies on the roll. Professor Horatio Hale, of Clinton, Ontario, philologist to Wilkes's expedition; Mr. E. Meyrick, B.A., of Marlborough College, Wiltshire, England, for New Zealand Micro-lepidoptera.

Papers.—1. "Polynesian Migrations" (Chapters VI. and VII., Conclusion), by Joshua Rutland; communicated by E. Tregear, F.R.G.S. (*Transactions*, p. 37)

Mr. Tanner said it was strange that these double boats could live in the open ocean. Why should not these natives, who in many ways were so clever, have progressed more than they had done? The carvings in Easter Island were most wonderful. There must have been something like priestcraft at work.

Major-General Schaw said the native boats at Ceylon were built on the same principle as those referred to; they could sail either way, but preferred the windward. They went long distances, and sailed like birds.

Mr. Travers was surprised that Mr. Rutland had made no mention of the monuments in the ancient cities of Central America, which were similar to those in Egypt. He mentioned that the French had discovered the Rosetta stone, which was the key to the reading of the Egyptian hieroglyphics But there did not appear to be any clue to the origin of these wonderful carvings on Easter Island. He said there was a great field open for discovery on these Polynesian Islands. He mentioned the distribution of plants as most important, and he hoped full collections would be made. The paper was most suggestive and interesting.

Major-General Schaw added that it was strange to find such wonderful monuments and carvings on such a small island; might it not be the remains of a much larger island, or continent?

Mr. Tregear said he had been very pleased to be able to bring so suggestive and valuable a paper as Mr. Rutland's before the Society. There were several points on which he did not hold the same opinion as Mr. Rutland, and it was probable that others would also disagree, but this fact only showed the great use of starting lines of thought on this subject which would provoke others to write papers from these texts. He (Mr. Tregear) did not agree with Mr. Rutland's speaking of the Maori as belonging to the Malay family; ethnologically the Malay and Polynesian were of totally distinct types, and this was now generally recognised. Why the Polynesians did not use pottery, when they were in contact with islanders who did so, was one of the puzzles of the Pacific, and, like the absence of the bow and arrow as war-weapons among the light-brown people of Oceania, had not yet found explanation. The Pacific was full of unsolved problems and mysteries. The greatest of these was Easter Island. The fact of the existence of great statues on Easter Island, of a pyramid in Tahiti, of huge walls on Ponape and Strang Island only

showed that in ancient days much labour had been expended by some persons on stone-work, but did not by any means bear out a theory as to the common race He (Mr. Tregear) was fortunately able to show to the meeting photographs of the different scenes alluded to by Mr. Rutland. The great temple of Boroboro, in Java, was indeed one of the wonders of the world, and was, as Alfred Wallace had said, far more wonderful than the Pyramids. It was the most gigantic effort in the realm of human labour and human skill. If we turned from this picture to those showing the walls of Ponape we were at the other extremity of the land of art. In Ponape we found walls built of huge basaltic stones, stacked in layers exactly like stacks of firewood Only foresters used to dealing with fallen logs would ever dream of mural erections like these. Then, at the other boundary of the South Seas, on solitary Easter Island, they again came upon statuary, but statuary of a unique and archaic description. Figures whose features resembled those of no living race; figures made for no apparent purpose except that of being ranged in a long seaward line as "gods of boundaries," watching the ocean from that small barren island. That Easter Island was the last remnant of the mythical sunken continent sometimes alluded to as "Lemuria" is improbable. If a continent had sunk, only the tops of snow-clad peaks would have remained above the water, and these would have been for a long time uninhabitable by men. There was little doubt but that there was extensive navigation among the South Sea Islands before Europeans came, for the double canoe or outrigged canoe was not only one of the fastest but the safest of vessels That no trace of palæolithic man had been found yet in Central America was too small a point on which to hang the theory that the high civilisation necessary to produce the architecture of Palengone and other places had been introduced full-grown Egypt was for a long time thought to be also without evidence of palæolithic occupation, but later researches had resulted in the discovery of chipped-stone implements, &c. So also Central America, when explored as Egypt had been explored, might yield up the tools and weapons of her earliest men. He believed that these papers of Mr. Rutland's would set several persons writing on portions of the subject next year, and he hoped to be able himself to give some information and to receive much information in papers originated by Mr. Rutland's able series of articles.

2. "On the Plants grown at 'The Gums,' Taita," by T. Mason. (*Transactions*, p. 393.)

Mr. Travers said the lists of plants accompanying this paper would prove most useful to those persons who were engaged in planting in this country.

The President, on behalf of the members, congratulated Mr. Tregear on his lately receiving from the French Minister for Education the Order of the Palm-leaf, in recognition of his scientific work in New Zealand.

Mr. Tregear thanked the members for their kind wishes.

Ninth Meeting: *20th January, 1897.*

Mr. W. T. L. Travers, F.L.S., President, in the chair.

It was notified that Major-General Schaw, C.B., R.E., a member of the Society, had been elected a Governor of the New Zealand Institute for the current year, and that Professor Horatio Hale, of Ontario* (nominated by the Society), together with Mr. Richard Lydekker, of the British Museum, had been elected honorary members of the New Zealand Institute.

Papers.—1. "On some Tick-parasites of the Kiwi," by W. M. Maskell. (*Transactions*, p. 290.)

In answer to questions, the author stated that the genus of ticks which in other countries infested animals, as in Queensland and elsewhere, affected birds in New Zealand. There was, he thought, a chance of these ticks going on to cattle in this country. He did not think the Queensland tick would come here, as it seemed only to thrive in the tropics The difference between ticks and insects was that the insect had six legs while the tick had eight.

Sir James Hector pointed out the importance of such a paper as that read, which was one of the first attempts to deal scientifically with the tick-pest.

The President also referred to the value of the investigations by Mr. Maskell.

2. "Further Notes on Coccids, with Description of New Species," by W. M. Maskell. (*Transactions*, p. 293.)

The President said it was gratifying to know that Mr. Maskell was still investigating these injurious insects; the work was most valuable, and entailed a great deal of labour and close application.

3. Sir James Hector brought before the Society the necessity of the preservation of ancient Maori records.

He said the rapid extinction of Maori customs, and the consequent loss to the scientific world of much information in an interesting branch of study, had rendered necessary prompt action on the part of the New Zealand Institute in order to preserve records of the unique characteristics of the race. The first step in this direction would be the publication of a valuable illustrated work upon Maori art, the first number of which was expected to be ready within a fortnight. He showed an advance copy of the first part of the five which would make up the volume. The first portion was devoted to Maori canoes, and was illustrated with excellently-taken and reproduced photographs of the carvings upon the Maori war-vessels. The other four parts would deal respectively with Maori habitations, weapons, ornaments, and dress. The work was being undertaken by Mr. Augustus Hamilton, Registrar of the Otago University, and arrangements had been made for Mr. Hamilton to go through all the Maori country and obtain the best photographs possible. The Institute had arranged for a complete collection of photographs and negatives of Maori art-workmanship.

* Unfortunately, news has been received that Professor Hale had actually died before the election was made, and it was, consequently, void; and Professor Langley has been elected instead.

A number of these photographs, as well as bromide enlargements, were on exhibition, and were much admired.

4. Sir J. Hector exhibited a specimen of the very rare metal Osmium-iridium, found at Parapara, Collingwood.

He stated that the appearance of this metal always indicated country of a very high metallurgic value. Osmium-iridium was worth about twice the value of gold; and another metal, Palladium—traces of which were to be seen in the specimen exhibited—was worth very much more. The only article known which was made of this metal was a small goblet in the Paris mint. The bearings of the standard balances in the mints at Paris and London were also made of this rare metal, at enormous cost. Osmium iridium was used for the hard tips upon gold nibs, &c. Both these metals were found at Parapara mixed with the gold recovered by the company in that locality. But what this colony should find was Thorium, which used to be worth nearly £40 an ounce, and was now in great demand for making the mantles used over gas-burners He added that he believed it might perhaps be found in New Zealand. Owing to recent discoveries in Brazil its value was now much reduced.

5. Sir J. Hector gave a short account of the recent "rain of blood" in Australia, and exhibited a specimen of the red dust collected from vegetation after the sanguinary shower, received from Mr. Krull.

He said he had examined it and found that it was largely composed of ferruginous clay. It was probably dust swept up into a cloud from the dry parts in the interior of the Australian Continent. When the cloud condensed the red dust came down with the rain. The dust showed evidences of containing vegetable matter such as would be likely to form on the surface of dried-up lakes.

ANNUAL MEETING: *17th February, 1897.*

Mr. W. T. L. Travers, President, in the chair.

The report and balance-sheet were read and adopted. The balance-sheet set forth the receipts for the year (including the balance brought forward, £66 17s. 8d.) to be £171 17s. 8d., the expenditure £90 9s., and the balance £81 8s. 8d., to which has to be added £31 5s. 6d. lodged in the bank at interest as a "Research Fund": making a total credit balance of £112 14s. 2d.

OFFICE-BEARERS.—The four retiring members—viz., the President (Mr. Travers), one Vice-president (Mr. R. C. Harding), and two members of the Council (Mr. Tregear and Major-General Schaw)—were all re-elected, as follow; Mr. R. L. Mestayer being elected in the place of Mr. Farquhar, who resigned. *President*—W. T. L. Travers, F.L.S.; *Vice-presidents*—R. C. Harding, E. Tregear, F.R.G.S.; *Council*—Sir W. Buller, K.C.M.G., F.R.S., W. M. Maskell, G. V.

Hudson, F.E.S., T. Kirk, F.L.S., Major-General Schaw, C.B., R.E., Sir James Hector, K.C.M.G., F.R.S., E. L. Mestayer, M.Inst.C.E.; *Secretary and Treasurer*—R. B. Gore; *Auditor*—T. King.

The President proposed a vote of thanks to the Auditor and to the Secretary, which was carried.

Papers.—1 "Notes on the Ornithology of New Zealand," by Sir W. Buller. (*Transactions*, p. 179.)

Sir James Hector said he considered the notes on the birds valuable. He had just received the concluding volume of Professor Newton's great work, the "Dictionary of Birds," and was interested to find that, from the examination of the specimens in the flesh sent Home for comparison, it had been decided that the flightless duck of the Auckland Islands (*Nesonetta aucklandica*) was only a modified form of the red teal of New Zealand (*Anas chlorotis*). Dr. Collins, who shot specimens of the former in the Auckland Islands, was certain that he saw the same flightless duck in a small permanent pool on the top of the Snares Island, which would be a new locality.

Sir W. Buller said he had listened to Sir James Hector's remarks with much interest. He had not yet received the fourth volume of Professor Newton's "Dictionary of Birds." The announcement made by Sir J. Hector about *Nesonetta aucklandica* was therefore new to him, and its importance, from a Darwinian point of view, could hardly be overestimated. If Professor Newton was right in his conclusion that *Nesonetta aucklandica* was a direct descendant from *Anas chlorotis*—and he, for one, would pin his faith to the Professor—they had here a wonderful instance of evolution, for the brown duck of New Zealand and the flightless duck of the Auckland Islands were not merely distinct species, exhibiting entirely different habits, but represented different genera. As to the flightless duck of the Snares, which Dr. Collins describes as being exactly the same as that found at the Auckland Islands, he had no reason to doubt that there was such a bird on the Snares, but he thought it very unlikely that it would prove to be the same as *Nesonetta aucklandica*, for it might have taken many hundreds of years to develope the flightless form, and, as there would be no communication between the Auckland Islands and the Snares, the development (assuming the New Zealand bird to be the ancestor) would be on divergent lines. The Snares bird would in all probability prove to be something quite new, and it was very desirable to obtain specimens for critical examination.

The following papers were read by Mr. T. Kirk, F.L.S.: 2. "Description of a New Genus of *Gramineæ*" (*Transactions*, p. 497). 3. "Remarks on *Paratrophis heterophylla*, Bl., of New Zealand" (*Transactions*, p. 498). 4. "On *Carmichaelia*, *Corallospartium*, *Huttonella*, and *Notospartium*" (*Transactions*, p. 501). 5. "Notes on the Botany of the East Cape District" (*Transactions*, p. 509). 6. "On the History of Botany in Otago" (*Transactions*, p. 532).

Sir James Hector said the East Cape district was very interesting from its geological structure. He had surveyed it in 1874, and published a map and sections. A large area was occupied by green sandstones, conglomerate, and shales of Upper Secondary age, and the Hikurangi Range was in geological structure not unlike the Hokonui in Southland. This might account for the exceptional character of the flora mentioned by the author.

Mr. Travers said the rich and varied flora was no doubt accounted for by the complicated geological conditions mentioned by Sir J. Hector.

Mr. Kirk, in reply, said that their chief knowledge regarding the botany of the East Cape was derived from the report of the visit to Tolago Bay by Dr. Solander with Captain Cook. The south limit of the puriri was sixteen miles north of Poverty Bay, where it reaches considerable dimensions, further north the forest was luxuriant, but the timber difficult to get out In regard to general botany, there was no other locality in New Zealand that formed the meeting ground of so many species

7. "On Volcanic and Seismic Phenomena," by H. C. Field.

Abstract.

After the eruption of Ruapehu, in March, 1895, the sulphur stream which formed the highest source of the Wangaehu River ceased to flow, and the water had apparently, till within the last few days, been always sweet and pure On the 15th instant large numbers of kahanaenae (New Zealand loach) floated dead in this stream, and others were dying and gasping for breath The water had also again become turbid and sulphurous. The floating of lead fish continued for several days, and the water was still milky looking, and smelt of sulphur No doubt the fish floating down the Wangaehu were thus on their way to the salt water when they were killed by the sulphurous water, and the recent volcanic activity inland had reopened the sulphur spring

4. "On the Oxidation of Mercury in Air and Water, and of Iron in Alkaline Solutions," by W Skey (*Transactions*, p 582.)

5. "On the Conductivity of certain Substances for Electricity of Low Tension,' by W Skey (*Transactions*, p 581)

AUCKLAND INSTITUTE.

First Meeting: *8th June, 1896.*

Mr. D. Petrie, President, in the chair.

New Members.—A. T. Potter, A. T. Pycroft, R. H. Shakespear, E. Yates, J. E. Yates.

The President delivered the anniversary address, taking as his subject "A Modern Chapter in Vegetable Physiology." (*Transactions*, p. 427.)

Second Meeting: *22nd June, 1896.*

Mr. D. Petrie, President, in the chair.

Professor F. D. Brown gave a popular lecture on Fluorescence, accompanying it with numerous experimental illustrations.

Third Meeting: *6th July, 1896.*

Mr. D. Potrie, President, in the chair.

New Members.—H. Boscawen, R. Briffault, P. Marshall, M. Keesing.

Papers.—1. "Notice of the Occurrence of *Diadema nerina* at Hamilton, Waikato," by S. T. Seddon.

On the afternoon of the 20th of April last, when the sun was in its power, our garden was graced by the presence of a most beautiful butterfly (*Diadema nerina*). It was seen by Mrs. Seddon, myself, and the servant; it stayed with us about a quarter of an hour, sipping honey from petunias, phlox, and heliotrope. It was a large insect, measuring about 4in. in expanse of wing. The predominant colour was velvety black, with broad white markings, and a small white spot at the apex of each upper wing, and a large round white spot in the middle of each lower wing, surrounded by a zone of iridescent purplish blue, which in some lights was emerald-green. The whole insect was covered with velvety hairs inclining to brown over the body and adjacent parts. The broad white markings on the upper wings were most distinct when the insect was looking down from above. It is very powerful in flight, which resembles that of *Vanessa atalanta*. *Diadema nerina* is decidedly the queen of New Zealand Lepidoptera, and, although I have been in New Zealand thirty-six years without seeing this beautiful butterfly, I am already hungering to see it again.

Mr. Cheeseman said *Diadema* appeared to be very scarce in New Zealand, although not uncommon in Australia and some parts of Polynesia. It was first collected by Dr. Sinclair, who sent a specimen to the British Museum about 1855. Since then not more than ten or twelve specimens appear to have been taken in all.

2. "Notes on the Cicadas of New Zealand," by A. T Potter. (*Transactions*, p. 280.)

3. "On Fires in Coal-ships: Their Causes and Prevention," by J. C. Firth. (*Transactions*, p. 100.)

Fourth Meeting: *20th July, 1896.*

Professor A. P. Thomas, Vice-president, in the chair.

Mr. F. G. Ewington gave a popular lecture on South Africa.

Fifth Meeting: *3rd August, 1896.*

Mr. D. Petrie, President, in the chair.

New Member.—Rev. Mr. Major.

Papers.—1. "Descriptions of New Native Plants," by D. Petrie, F.L.S. (*Transactions*, p. 425.)

2. "Supplement to the List of Flowering-plants indigenous to Otago," by D. Petrie, F.L.S. (*Transactions*, p. 421.)

3. "Notice of the Establishment of *Vallisneria spiralis* in Lake Takapuna, together with some Remarks on its Life-history," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 386.)

4. "On the Disappearance of the New Zealand Bush," by the Rev. P. Walsh. (*Transactions*, p. 490.)

Sixth Meeting: *17th August, 1896.*

Mr. D. Petrie, President, in the chair.

Professor C. W. Egerton gave a popular lecture on Carlyle.

Seventh Meeting: *7th September, 1896.*

Professor A. P. Thomas, Vice-president, in the chair.

New Member.—Mr. W. R. Walker.

Papers.—1. "Note on *Gunnera ovata*," by D. Petrie, F.L.S. (*Transactions*, p. 422.)

2. "The Narcissus: its History, Varieties, and Cultivation," by Professor A P. Thomas, F.L.S.

EIGHTH MEETING: *21st September, 1896.*

Mr. D. Petrie, President, in the chair.

Professor H. W. Segar gave a popular lecture, entitled "A Month with the Maori."

NINTH MEETING: *5th October, 1896.*

Mr. D. Petrie, President, in the chair

New Member.—C. E. Parsons.

Papers.—1. "Described Species of New Zealand *Araneæ* omitted from the Catalogue of 1891," by A. T. Urquhart. (*Transactions*, p. 284.)

2. "Notes on the Occurrence of Kauri-gum in the Kahikatea Forest at Turua, Thames, by L. J. Bagnall. (*Transactions*, p. 412.)

3. "Some Recent Additions to the Flowering-plants of New Zealand," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 390.)

4. "On the Flora of the North Cape Peninsula," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 333.)

TENTH MEETING: *19th October, 1896.*

Mr. J. H. UPTON, Vice-president, in the chair.

Dr. E. Roberton gave a popular lecture on Antitoxins.

ANNUAL MEETING: *22nd February, 1897.*

Mr. D. Petrie, F.L.S., President, in the chair.

ABSTRACT OF ANNUAL REPORT.

The number of members on the roll on the 1st February, 1897, was 173, of whom fifteen are life members and 158 annual subscribers. Twelve new members have been elected during the year; but, on the other hand, eleven names have been removed—one from death, five

from resignation, and five from non-payment of subscription for more than two consecutive years. The deceased gentleman is Mr. Camille Malfroy, so well known from his ingenious experiments on the mode of controlling the action of the smaller geysers at Rotorua.

Full particulars respecting the financial position of the Institute are given in the balance-sheets appended to this report, but for the sake of clearness it is advisable to give a brief summary here. The total revenue, excluding the balance of £60 9s. 1d. brought from last year, has been £1,207 7s. 8d. The receipts for the previous year, which were much below the average, were £877 13s 3d., so that there is an increase of £329 14s. 5d. This is mainly due to the enlarged receipts from the Museum endowment—presently to be alluded to—and the payment of some arrears of interest which would, if paid when due, have been included in last year's balance-sheet. Comparing the separate items, it may be noted that the receipts from the invested funds of the Costley bequest stand at £499 5s., as against £388 9s 7d. for 1895–96; the Museum endowment has yielded £569 12s. 2d., the amount for the previous year being £340; while the sum derived from the members' subscriptions is almost the same as that credited in last year's balance-sheet. The total expenditure has been £1,102 18s. 11d., leaving a credit balance of £164 17s. 10d. in the Bank of New Zealand. The gratifying increase in the revenue has permitted the Council to repay the balance of £200 owing to the Investment Account on the purchase of the Maori-house; and also to carry out some long-needed improvements in the Museum.

The resumption of gold-mining in the Cape Colville Peninsula has resulted in the greater portion of the Waikanae Block, near Cabbage Bay, being taken up under mining lease. The receipts from this source have amounted to over £200, forming a very welcome addition to the Society's funds. With this exception, there is little to report concerning the endowments. Few sales have been effected; in fact, there appears to be little chance of the disposal of the remainder of the endowment at satisfactory prices. From time to time the Crown Lands Board have handed over the rents of those sections which are leased; and the interest on the invested funds of the endowment has been regularly received.

Ten meetings have been held during the year, at which twenty papers were read and discussed.

With the exception of Christmas Day, and a short period devoted to cleaning and rearrangement, the Museum has been open to the public on every day during the year. The attendance of visitors has been satisfactory, and shows a considerable increase, so far as can be judged from the data in the possession of the Curator. On Sunday afternoons the visitors are regularly counted, the register kept by the attendant showing that 12,388 persons entered the building on that day, or an average of 238 for each Sunday. This shows an increase of 2,234 on the number for the previous year. On week-days the visitors can only be occasionally counted; but the daily average is estimated to be about 105. The approximate week-day attendance would consequently be 32,865, and the total for the whole year 45,253. The largest attendance recorded on any one day was 413, on the 25th May (Queen's Birthday).

For some time past the Council have been sensible that a further enlargement of the Museum could not be long postponed. At present the centre of the main hall is chiefly occupied by the collection of plaster casts of Greek statues, presented by Mr. T. Russell, C.M.G. This collection, in many respects an admirable one, is altogether out of place in its present situation, surrounded by stuffed birds and animals, and of necessity arranged in such a manner that its use by art students is greatly limited. Its presence gives an incongruous appearance to the hall,

while it effectually prevents the extension and proper arrangement of the Natural History Department. Under these circumstances the Council have determined to erect a new hall, 50ft. square, on the eastern side of the Ethnographical Hall, with which it will be connected by an archway. It will contain the Russell collection of statues, and can also be used for those meetings of the Institute likely to attract a larger audience than can be accommodated in the present lecture-room. Plans of the building have been prepared by Mr. Bartley, and a contract for its erection has just been taken for the sum of £800.

When the statues are transferred to the new hall it is the intention of the Council to fill the space which they at present occupy with groups of the larger mammals, arranged in suitable glass cases. The work will of necessity extend over some years, but when completed will add largely to the general appearance of the Museum and its usefulness to the public. In connection with this subject, the Council have great pleasure in informing the members that Mr. T. Russell has recently offered, through a member of the Council visiting London, to expend the sum of £100 in any direction which the Council might consider of advantage to the Museum. The Council have communicated with Mr. Russell, thanking him for his liberal and generous offer, and suggesting that his donation might be used to procure a group of the larger Carnivora.

Numerous donations have been received during the year. So far as regards the additions to the Zoological Department, it has been impossible to do more than pack up the specimens as they are received, for, until the pending alterations to the Museum are completed, room cannot be found for their exhibition. Among the New Zealand birds added to the collection are some remarkably fine specimens of the "roa," or large kiwi, from Stewart Island, obtained by purchase, a pair of skins of a rare cormorant (*Phalacrocorax stictocephalus*) and a skua gull, presented by Mr. A. T. Pycroft; a specimen of the true curlew (*Numenius cyanopus*), shot in the Manukau Harbour, being the first recorded instance of its occurrence in the Auckland district, presented by Mr. Newell; and a small, but highly interesting, collection of bird-skins from the Chatham Islands, obtained by purchase.

A valuable collection of minerals, including many specimens of great beauty, has been purchased from Professor H. A. Ward, of Rochester, U.S.A. The Museum is also indebted to Mr. J. A Pond, Mr. J. Park, and Mr. J. Chambers for several interesting ores and minerals from the Thames Goldfields.

The Ethnological Hall, and especially that part of it devoted to the Maori collection, continues to attract a large number of visitors, particularly among the class of tourists and travellers. A considerable number of small additions have been made during the year, mostly by purchase, and it is obvious that additional case-accommodation will soon be required.

Early in the year the Council sanctioned the expenditure of from £60 to £70 in the purchase of standard scientific works, a list of which is appended. Special attention may be drawn to D'Urville's "Voyage of the 'Astrolabe'"; to the Royal Society's Catalogue of Scientific Papers, of which important publication the society now possesses the whole of the parts which have so far appeared; and to an almost complete set of Hooker's "Icones Plantarum," a work indispensable to New Zealand botanists from the large number of native plants figured therein. The Council have great pleasure in stating that they have received an intimation to the effect that the Imperial Government have decided to present to the library a complete set of the publications of the "Challenger" Expedition. The importance of this edition to the library can hardly be overestimated, containing, as it does, valuable monographs in almost every branch of zoological science. The usual exchanges and presenta-

tions from foreign societies have also been received, together with some donations from private individuals.

The steps which have been taken by the Government to constitute the Little Barrier Island a reserve for the preservation of the fauna and flora of New Zealand are no doubt fresh in the recollection of members. Soon after the last annual meeting the Council received a communication from the Government asking whether the Institute would undertake the management of the island, the Crown Lands Department contributing a yearly grant to defray the necessary expenses. As the proposal to reserve the island emanated from the Institute, and has always had its active support and sympathy, the Council at once stated their willingness to undertake the work. The negotiations lingered, however, and it was not until the end of the year that the island was formally handed over, together with a grant of £200 for the first year's expenses Mr. R H. Shakespear has been appointed curator, and left for the island early in the month of January. A residence is urgently wanted, and the Council trust that the Government will act on their representations and erect one before the winter sets in.

A visit of inspection has proved that most of the rarer birds known to inhabit the island still linger thereon, in some cases in fair numbers. Now that Maoris and Europeans have practically left the island, and now that a caretaker armed with sufficient powers to prevent the landing of unauthorised persons is residing there, it is hoped that the depredations of collectors will be effectually stopped. Fortunately, wild cats and other vermin appear to be scarce, and there is every probability that the island may for many years afford a secure home to species that have either disappeared or will shortly disappear from the mainland.

In conclusion, the Council have once more to thank the members and many others for the aid and encouragement which they have given to the objects of the Institute, and which they trust will be again freely rendered during the coming year.

Election of Officers for 1897.—*President* - E Roberton, M.D.; *Vice-presidents*—D. Petrie, F.L.S., Professor A. P Thomas, F.L.S.; *Council*—G. Aickin, J. Batger, W. Berry, H. Campbell, C. Cooper, E. A. Mackechnie, T. Peacock, Rev. A. G. Purchas, M.R.C.S.E., J. Reid, J. Stewart, C.E., J. H. Upton; *Trustees*—E. A. Mackechnie, S. P. Smith, F.R.G.S., T. Peacock; *Secretary and Curator*—T. F. Cheeseman, F.L.S., F.Z.S.; *Auditor*—W. Gorrie.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

FIRST MEETING: *6th May, 1896.*

Professor Dendy, D.Sc., President, in the chair.

New Members.—G. G. Bridges and C. F. Bourne, M.A.

Papers.—1. "On the Leg-bones of *Meionornis* from Glenmark," by Captain Hutton, F.R.S. (*Transactions*, p. 557.)

2. "On Two Moa-skulls," by Captain Hutton. (*Transactions*, p. 561.)

3. "On the Occurrence of *Virgularia gracillima* in Lyttelton Harbour," by Professor Dendy, D.Sc. (*Transactions*, p. 256)

4. "On New Zealand Mortality," by C. E. Adams, M.A. (*Transactions*, p. 52.)

The following exhibits were shown and described: One of the earliest forms of compound microscope, by Professor Dendy; a harmonograph, by G. Julius; a peculiar formation of seeds from Lake Ellesmere, by Captain Hutton.

SECOND MEETING: *3rd June, 1896.*

Professor Dendy, President, in the chair.

New Members.—Dr. Boyd and Dr. Ovenden.

Address.—"The Historical Development of Domestic Art," by S. Hurst Seager, A.R.I.B.A.

THIRD MEETING: *1st July, 1896.*

Professor Dendy, President, in the chair.

New Members.—R. D. Duxfield, T. S. Foster, E. W. Roper, T. W. Stringer, W. J. Cresswell, Professor Mathew, and Professor Michell-Clarke.

Papers.—1. "The Lizards indigenous to New Zealand," by A. H. S. Lucas, M.A., B.Sc., and C. Frost, F.L.S.; communicated by Captain Hutton. (*Transactions*, p. 264.)

2. "Notes on New Zealand Mosses," by R. Brown. (*Transactions*, p. 465.)

3. "Notes on Certain Species of New Zealand Ducks," by W. W. Smith. (*Transactions*, p. 252.)

4. "On the Sulphur in the Christchurch Gas," by Dr. W. P. Evans.

Fourth Meeting: *5th August, 1896.*

Professor Dendy, President, in the chair.

New Member.—W. J. Barnett.

Address.—"The French Miracle Plays," by Professor Michell-Clarke, M.A.

Fifth Meeting: *2nd September, 1896.*

Professor Dendy, President, in the chair.

New Member.—W. J. Carlisle.

Address.—"The Behaviour of Solids under High Intensity of Stress," by Professor R. J. Scott, M.A.

A number of experiments illustrating the subject were performed in the engineering laboratory, Canterbury College.

Sixth Meeting: *7th October, 1896.*

Professor Dendy, President, in the chair.

New Members.—W. D. Meares and F. Waymouth.

Address.—"Water Filtration," by Dr. W. H. Symes.

Seventh Meeting: *4th November, 1896.*

Professor Dendy, President, in the chair.

New Member.—Dr. Campbell.

Address.—"The Improvement of Wild Flowers by Artificial Selection," by L. Cockayne.

The address was illustrated by a very large number of exhibits of cut and pot plants.

Papers.—1. "A Comparison of the Animal Mind with the Human Mind," by C. W. Purnell. (*Transactions*, p. 71.)

2. "Notes on Certain Species of *Delesseria*, including One New One," by R. M. Laing, M.A. (*Transactions*, p. 446.)

3. "The Moas of the North Island," by Captain Hutton. *Transactions*, p. 541.)

4. "The *Stenopelmatidæ* of New Zealand," by Captain Hutton. (*Transactions*, p. 208.)

5. "Note on the *Mantis* found in New Zealand," by Captain Hutton. (*Transactions*, p. 242.)

6. "Notes on New Zealand Mosses," by R. Brown. (*Transactions*, p. 478.)

7. "On New Zealand Mosses," by T. W. Taylor-Beckett. (*Transactions*, p. 441.)

8. "Synonomic List of New Zealand Lepidoptera," by R. W. Fereday.

Eighth Meeting: *30th November, 1896.*

Professor Dendy, President, in the chair.

New Members.—W. Walton, B.A., E. Cuthbert, C.E., G. Anderson, F. Meddings, Dr. Townend, and Dr. Diamond.

Papers.—1. "Order in the Irregularity in the Periodic Law," by Professor Bickerton.

2. "On the Cosmic Importance of Helium and other Light Gases," by Professor Bickerton.

3. "Notes on the Land Planarians of New Zealand: Part III.," by Professor Dendy, D.Sc. (*Transactions*, p. 258.)

4. "The Refraction and Reflexion of *x*-rays," by Dr. W. P. Evans. (*Transactions*, p. 573.)

5. "The Bromine Method of estimating Sulphur in Gaseous Compounds," by Dr. W. P. Evans. (*Transactions*, p. 573.)

Annual Meeting: *7th April, 1897.*

Professor Dendy in the chair.

Abstract of Annual Report.

During the year nine ordinary meetings have been held, at which twenty papers have been read, which may be classified as follow: Zoology, 5; botany, 4; geology, 4; chemistry, 2; physics, 3; miscellaneous, 2. Four special addresses of a less technical character have also been delivered at the ordinary meetings. The attendance at the

ordinary meetings has largely increased, the average being twenty-six and the highest forty-nine.

A special popular lecture on "The Röntgen Rays and their Use in Photography" was delivered in the Art Gallery by Dr. W. P. Evans, and was a success in every way.

The list of members has risen from sixty-five to seventy-eight, and the number of associates is now seventy two. The total receipts for the year have been £34 2s., and the expenditure £41 14s. 9d., which, with last year's balance of £24 12s. 5d., leaves the Institute with a balance of £16 19s. 8d.

ELECTION OF OFFICERS FOR 1897.—*President*—Dr. W Thomas; *Vice-presidents*—Dr W. P Evans, Mr R Speight, *Hon. Secretary*—Professor Dendy; *Hon. Treasurer*—Captain Hutton; *Council*—Dr. Symes, Messrs H. R. Webb, S. Page, L. Cockayne, F. C. Binns, R M Laing; *Auditor*—R. C Bishop.

Presidential Address.—The retiring President, Professor Dendy, delivered an address on "Some Recent Progress in Biology."

OTAGO INSTITUTE.

First Meeting: *12th May, 1896.*

Mr. A. Hamilton, President, in the chair.

New Members.—John Ewing, W. McConnochie, A. T. Cavell, George Roberts, Miss Allman Marchant, M.A., B. Cracroft Aston, A. Michael, C. W. Hay, A. J. Kidston-Hunter, R. G. Whetter, M.A.

The President announced that Mr. J. G. McLeod had resigned his seat on the Council, and that Professor Shand had been elected to the vacant seat.

Professor Shand gave a lecture on "The Electric Discharge, and Rontgen Photographic Rays," illustrated by numerous experiments.

Mr. G. M. Thomson gave a brief account of the report of the committee appointed last year to consider the establishment of a fish-hatching station. He stated that the committee had made inquiries, personally inspecting various localities, and had come to the conclusion that Purakanui was the most suitable spot in the neighbourhood for the purpose.

The report was adopted, and it was resolved, "That a committee, consisting of Messrs. Hamilton, Parker, Don, Chapman, and Thomson, be appointed to confer with a committee of the Acclimatisation Society, and with the members of both Houses of the Legislature, with a view of taking such steps as will lead to the establishment of a marine fish-hatchery at Purakanui."

Second Meeting: *9th June, 1896.*

Mr. A. Hamilton, President, in the chair.

New Members.—P. C. Corliss, F. J. Stilling, F. E. Brittain, Rev. W. Hewitson, J. A. Johnstone, R. Sandilands, C. R. Richardson, B.A., J. Crosbie Smith.

Papers.—1. Professor Parker gave an account of the leading structural peculiarities of a large sun-fish (*Orthagoriscus mola*) captured in the Upper Harbour in March last, and lately mounted for exhibition in the Museum. The specimen is 8ft. 6in. in length, 6ft. in height, and 11ft. from tip of dorsal to tip of ventral fin. It weighed 1¼ tons. The anterior contour is characterized by a gently-curved projection above the mouth, from the dorsal end of which there is a backward slope to the middle line of the back. Below the mouth is a similar chin-like projection. Two strong, deep, horizontal ridges run along each side of the trunk, one above, the other below, the branchial aperture and pectoral fin.

The brain and spinal cord were exhibited (together they are not more than 1½in. in length); also sections, in alcohol, of the skull and fin-rays, showing the very incomplete ossification of the cartilage. On the skin were found numerous specimens of the parasitic copepod *Lepeophtheirus nordmanni*. The intestine contained immense numbers of a species of *Tænia*, and a *Distoma*.

2. "Notes from Murihiku: being a Description of some Rock Pictographs on the Waitaki, and Notes on a Maori Kete containing Textile Fabrics and Materials," by A. Hamilton. (*Transactions*, p. 169.)

Mr. G. M. Thomson gave a verbal report of the work done since the last meeting by the Fisheries Committee.

He stated that a meeting had been held between the committee, the council of the Acclimatisation Society, and the members of the General Assembly resident in Dunedin, at which it was resolved to impress strongly upon the Government the desirability of establishing a fish-hatchery at Purakanui, as proposed by the committee. Mr. Thomson also stated that he had written to the Chairman of the Scottish Fisheries Board and to the United States Commissioner for Fisheries for certain specific information on the matter.

THIRD MEETING: *14th July, 1896.*

Mr. A. Hamilton, President, in the chair.

New Members.—John Angus, D. Clarke, J. T. Bryant, J. Langmuir, J. Skottowe Webb.

Paper.—"Review of the Theories that have been advanced to account for the Occurrence of Gold in Auriferous Lodes," by J. B. Don, D.Sc.

FOURTH MEETING: *11th August, 1896.*

Mr. A. Hamilton, President, in the chair.

New Members.—J. H. Stanley, John Blair, T. J. Collins.

Mr. C. W. Adams gave a lecture on "Fire-raising by Friction." The lecture was illustrated by two Maoris, Hamahona Tiro and Hoani Rakiraki, who produced fire by the stick-and-groove method.

Dr. Hocken read a note "On a Piece of Aztec Statuary representing the Sacrifice of a Human Victim."

FIFTH MEETING: *8th September, 1896.*

Mr. A. Hamilton, President, in the chair.

New Member.—Dr. W. Allan.

Professor Parker announced that a nearly-complete skeleton of *Harpagornis* had, through the kind offices of Messrs. N. and G. Donaldson, been deposited in the Museum. The bones, with numerous other avian remains, had been sluiced out of Messrs. Donaldson's claim at Macrae's.

Mr. George Hogben, M.A., Rector of the Timaru High School, gave an account of the work and aims of the International Seismological Committee, one of the stations of which it was proposed to establish at Timaru, under his superintendence.

The President announced that the Council had made a grant of £10 towards the expense of purchasing, erecting, and maintaining for one year the necessary instruments at the Timaru station.

Paper.—"The Rise and Growth of the New Zealand Constitution," by Dr. Hocken.

SIXTH MEETING: *13th October, 1896.*

Mr. A. Hamilton, President, in the chair.

The following resolution was passed: "That this Institute has heard with profound regret of the death of the distinguished botanist Baron Sir Ferdinand von Mueller, and desires to place on record its sense of his eminent services to science."

Mr. G. M. Thomson exhibited, and handed over to the Otago University Museum, some fossil remains which had

been obtained by Mr. Leslie Reynolds from a mining-claim at St. Bathans, Central Otago. The specimens consisted of portions of stems, leaves, and capsules of a species of *Hakea*, embedded in a bed of hard clay, probably of lacustrine origin. They were found at a depth of nearly 40ft. below the present surface. At the present time the genus *Hakea* is confined exclusively to Australia, from which about a hundred species have been described, and of these sixty-five are recorded from West Australia alone. Its occurrence, therefore, in New Zealand in Tertiary times opens up an interesting question as to the origin and former distribution of the genus, and of allied forms of *Proteaceæ*.

Professor Parker exhibited and made remarks upon the following recent additions to the Museum: (1.) A slab of limestone, from Waihola, containing numerous sharks' teeth, the type of *Oxyrhina von haasti*, Davis. (2.) An unusually large specimen of the Hoki (*Macrurorus zealandiæ*) recently obtained in the Otago Harbour. (3.) A specimen of *Mendosoma lineatum* recently obtained off the coast of Otago. (4.) A mounted specimen of the Stewart Island kiwi (*Apteryx lawryi*). (5.) Various representations of the abyssal fauna of the Indian Ocean, obtained during the dredging operations of the Indian Marine Survey. (6.) Disarticulated skeletons of *Callorhynchus*, *Heterodontus*, *Necturus*, and *Hyla*, mounted in alcohol. (7.) Disarticulated skeletons of *Notidanus* and *Raja*, prepared by impregnation with glycerine jelly. (8.) Disarticulated skeleton of the brown trout (*Salmo fario*), with the cartilaginous parts prepared by impregnation with paraffin.

Papers.—1. "Notes on the Birds of the Waitati Valley," by Alex. Wilson, M.A.

2. "A list of Species of *Polyzoa* collected in Various Parts of New Zealand," by A. Hamilton.

3. "Notes on a Deposit of Moa-bones, &c., at Deep Dell Creek, Macrae's," by A. Hamilton.

ANNUAL MEETING: *10th November, 1896.*

Mr. A. Hamilton, President, in the chair.

ABSTRACT OF ANNUAL REPORT.

During the session six general meetings and eight meetings of the Council have been held. Eight papers have been read, two lectures delivered, and several exhibits and demonstrations given. Early in the session Mr. J. G. McLeod resigned his seat on the Council, and the vacancy was filled by the election of Professor Shand.

The committee appointed last session to consider the establishment of a fish-hatching station reported that Purakanui was, in their opinion, the most suitable locality in the neighbourhood. The report was adopted, and a committee was appointed to take further steps in the matter.

The Council has voted the sum of £10 towards the establishment of a seismological observatory at Timaru.

A resolution has been carried by the Council advocating certain changes in the mode of publication and distribution of the Proceedings of the New Zealand Institute.

A resolution has been passed expressing regret at the death of Baron Sir Ferdinand von Mueller, and recording the sense of the Institute of his distinguished services to science.

The Council has nominated Mr. S P. Langley, secretary of the Smithsonian Institution, Washington, as an honorary member of the New Zealand Institute, and has again nominated Mr. James McKerrow to vote in the election of Governors.

The most important addition to the library during the session is a complete set of volumes of the "Challenger" Reports, presented by the Imperial Government to the University of Otago, and deposited in the Museum library.

Twenty-seven new members have joined the Institute during the session, making a considerably larger addition to the membership than the Council has had to record for several years. The total number on the roll is now 120.

The balance-sheet shows the total receipts for the year to be £82 19s., making, with the balance from last year, £113 3s. 10d. The expenditure for the year is £91 16s. 2d., leaving a credit balance of £22 7s. 8d.

Election of Officers for 1897.—*President*—J. R. Don, D.Sc.; *Vice-presidents*—A. Hamilton and Professor Shand, LL.D.; *Hon. Secretary*—Professor Parker, F.R.S.; *Hon. Treasurer*—J. S. Tennant, B.Sc.; *Council*—G. M. Thomson, F.L.S., Professor Scott, M.D., A. Wilson, M.A., F. R. Chapman, E. Melland, T. M. Hocken, F.L.S., A. Bathgate; *Auditor*—D. Brent, M.A.

Professor Parker exhibited and described the following additions to the Museum, all collected in Sydney Harbour: (1.) The animal of *Nautilus pompilius*, mounted so as to show the interior of the mantle-cavity. (2.) Egg-shells of the Port Jackson shark (*Heterodontus philippi*). (3.) *Dromia excavata* in commensal association with a simple ascidian. (4.) The same, in commensal association with a compound ascidian. (5.) *Octopus granulatus*. (6.) *Sepiola*, sp.

The retiring President delivered an address dealing principally with the construction of Maori pas and whares.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

First Meeting: *11th May, 1896.*

Rev. W. Colenso, F.R.S., F.L.S., President, in the chair.

The President read the inaugural address, dealing with the advantages to be derived from the study of the natural sciences, and with some remarkable scientific discoveries of the last twelve months. (*Transactions*, p. 129.)

At the close of the address the President announced his intention of donating a site for a museum and a sum of £1,500 for its construction, provided a further £2,500 were raised before the end of the year.

Second Meeting: *15th June, 1896.*

Rev. W. Colenso, F.R.S., F.L.S., in the chair.

Papers.—1. "On Fire, with Remarks on Native Methods of producing Fire," by the Rev. W. Colenso.

2. "The *Victoria regia* Lily," by the Rev. W. Colenso.

Third Meeting: *13th July, 1896.*

Rev. W. Colenso, F.R.S., F.L.S., in the chair.

Papers.—1. "On Some Common Shells of the Napier Beach," by F. Hutchinson.

2. "Arctic Adventure and Theories," by H. Hill, B.A., F.G.S.

Mr. Norris exhibited several trays of New Zealand Lepidoptera, caught and arranged by himself.

FOURTH MEETING: *18th August, 1896.*

Rev. W. Colenso, F.R.S., F.L.S., in the chair.

Paper.—"John Rutherford, the Pakeha-Maori," by Taylor White.

In the course of discussion the Chairman stated that shortly after his arrival in New Zealand he had made inquiries into the story in the places described by Rutherford without being able to discover any trace of him or of the events narrated by him, and had come to the conclusion that the story was largely mythical. The present Bishop of Waiapu had made similar inquiries, and had arrived at a similar conclusion.

Mr. H. Hill stated he had met a half-caste near the East Cape who passed as Rutherford's son, and bore his name.

FIFTH MEETING: *14th September, 1896.*

Rev. W. Colenso, F.R.S., F.L.S., in the chair.

Papers.—1. "New Lights on Old Egypt," by T. C. Moore, M.D.

2. "The Maori: To-day and To-morrow," by H. Hill, B.A., F.G.S. (*Transactions*, p. 150.)

Mr. Norris exhibited some trays of New Zealand Coleoptera, containing a large number of specimens beautifully mounted

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SIXTH MEETING: *12th October, 1896.*

Rev. W. Colenso, F.R.S., F.L.S., in the chair.

Papers.—1. "University Extension in New Zealand," by H. Hill, B.A., F.G.S.

2. "Artesian Water in Gisborne and Poverty Bay," by H. Hill, B.A., F.G.S. (*Transactions*, p. 567.)

3. "The Poua and Other Extinct Birds of the Chathams," by Taylor White. (*Transactions*, p. 162.)

[The following note was sent by the author, but too late for insertion with the paper.—ED.]:—

"*Re* the word *koko:* I have from the first and future readings of this sentence always felt a doubt as to whether '*the grass floating on the water, named koko*'—*i.e.*, duck-weed—is here meant in the Chatham Islander's narrative; or may we suppose the narrative to run thus: 'He eat grass'—*i.e.*, green food or plants—'he swim on waters of the lagoon; he call or say, *koko.*' To support this idea is the following quotation from 'Language and Languages,' by Canon Farrar, page 24: 'Yet in the following cases also, where the Sanskrit root runs through the whole Aryan family of languages, he ~~cannot avoid~~ referring the names to simple imitation.' . . . '*Koka*, a swan: imitative of the cry *kouk! kouk!*' Quoted from Pictet, 'Les Origines Indo-Européennes, ou les Aryas

Primitifs,' i., pp. 330–535. In the Malay of Macassar, *koko* means 'to cackle.'"—T. W., 19th April, 1897.

4. "Rats nesting in Trees," by Taylor White.

5. "Further Notes on the New Zealand Dog," by Taylor White.

6 "Curious Articles of Vegetable Food, and the Modes of Cooking in Use by the Maoris," by the Rev. W. Colenso.

7. "Some New Ferns," by the Rev W. Colenso. (*Transactions*, p. 414.)

Mounted specimens of all the ferns described, with others, were exhibited

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Special Meeting: *14th January, 1897.*

Paper.—"A Dust-shower in Napier," by H. Hill, B.A., F.G.S (*Transactions*, p. 571.)

Annual Meeting: *15th February, 1897.*

Abstract of Annual Report.

During the past year six ordinary meetings were held. Owing to various causes the attendance at the meetings has not been so good as in past years, with the exception of the first meeting. The number of papers received for reading was fourteen. The membership stands at seventy-seven, a slight decrease on last year. The outstanding subscriptions, when paid, will amply cover the indebtedness. During the year eight volumes have been added to the library. The Council has been able to avail itself of an offer of the Athenæum Committee to remove the Museum into the hall, and so acquire a larger space for the exhibits without any increase of rent. At the first general meeting, in May, the President, the Rev. W. Colenso, F.R.S., F.L.S., offered to donate a site and a sum of £1,500 for the purpose of erecting a suitable building for the Museum, on condition that a further sum of £2,500 was raised by the 31st December, 1896. The required sum not having been subscribed or promised, the President has withdrawn his offer. Hopes, however, are still entertained that something substantial may yet be done in that direction.

The balance-sheet shows the total receipts, including balance from previous year of £2 13s., to have been £56 10s., while the expenditure was £49 0s. 5d.

Election of Officers for 1897.—*President*—T. C Moore, M.D.; *Vice-president*—A. Milne-Thomson, M.B., C.M.; *Council*—C. E. Adams, J. W. Carlile, M.A., H. Hill, B.A., F.G.S., J. Hislop, Dr. J. E. H. Jarvis, T. Tanner; *Hon. Secretary*—W. Dinwiddie; *Hon. Treasurer*—G. White; *Auditor*—J. Crerar.

WESTLAND INSTITUTE.

ANNUAL MEETING: *December, 1896.*

ABSTRACT OF ANNUAL REPORT.

Considerable patience and perseverance had been required to maintain the Institute in anything like its former efficiency. Many disappointments and embarrassments had been met with during the year owing to the removal of subscribers. There had been a diminishing attendance. They had held nine committee meetings, mostly well attended. The trustees desired to convey their thanks to the Borough Council for their annual subsidy, likewise to those proprietors who donated papers to the reading-room. The members' roll now numbered fifty-seven, being rather small in proportion to the population. The library would shortly have a welcome addition of a case of new books, which had arrived and would soon be ready for circulation.

The balance-sheet showed—Receipts, £102 8s. 6d.; expenditure, £117 15s. 6d.; debit balance, £15 7s.

ELECTION OF OFFICERS FOR 1897.—*President*—Mr. A. H. King; *Vice-president*—Mr. D. Macfarlane; *Hon. Treasurer*—Mr. T. H. Gill; *Trustees*—Messrs. Chesney, Clarke, Beare, Dawes, Fowler, Gibson, Heinz, Lawry, Mahan, Michel, Sinclair, and Rev. S. Hamilton.

NELSON PHILOSOPHICAL SOCIETY.

First Meeting *8th June, 1896*

The Bishop of Nelson, President, in the chair.

Paper.—"On Experiments with Chemical Manures, and their Results," by W. F. Worley. (*Transactions*, p 588.)

Mr R I Kingsley gave a verbal account of his visit to West Wanganui, including the Golden Ridge, Lake Ngutuhehe, Anatori River, and down the coast to Big River, with a description of the flora and fauna and some geological features observed during the trip.

Mr Kingsley exhibited specimens of graptolites from the Upper Silurian, Golden Ridge Mr W Martin exhibited a mottled blackbird

Annual Meeting: *30th November, 1896.*

The Bishop of Nelson, President, in the chair.

Abstract of Annual Report.

The balance-sheet set forth the receipts for the year (including the balance brought forward, £14 7s. 8d.) to be £20 13s. 8d., the expenditure £11 4s. 10d. (of which £6 11s. was in connection with the Public Museum). A balance is brought forward of £9 8s. 10d.

The secretary's report gave particulars of the meetings held, and drew especial attention to the additions to the Museum collections resulting from Mr. E. Lukins's trip to the southern islands on behalf of the Society.

The curator reported the Museum to be in good order, but, as it was entirely without any public endowment, the expense of many much-needed improvements could not at present be incurred.

Election of Officers for 1897 —*President*—The Bishop of Nelson; *Vice-presidents*—A. S. Atkinson, F.L S, and Dr. W. J. Mackie; *Council*—Dr. L. Boor, E Lukins, W. F. Worley, J. G. Bartell, and J. Holloway; *Hon. Secretary*—R. I. Kingsley; *Hon. Treasurer*—Dr. J. Hudson; *Curator*—R. I. Kingsley; *Assistant Curator*—E. Lukins.

Mr. E. Lukins gave a verbal account of his trip to the southern islands, with some interesting facts relating to the specimens obtained.

Exhibits.—Male specimen of *Callorhynchus antarcticus*, by Mr. Litchfield. A specimen of black petrel (*Majaqueus parkinsonii*), from West Wanganui, by F. Johnston. A collection of coloured sketches of flowers from the southern islands, by Miss E. Harris.

Donations and Additions.—A fine specimen of the white heron, from the executors of the late Mrs. A. B. Suter. The arboreal trapdoor spider (*Migas sandageri*), by Mr. Sandager. Birds collected by Mr. Lukins: Young royal albatros, mollyhawk, penguin, dove petrel, flightless duck, shag, fern-bird, tomtit, bell-bird, green parrakeet, South Island crow, and sea-hawk.

At the close Mr. Kingsley exhibited lantern views of the islands, and various groups of birds there.

APPENDIX

METEOROLOGY.

Comparative Abstract for 1896 and Previous Years.

Stations.	Barometer at 9.30 a.m.		Temperature from Self-registering Instruments read in Morning for Twenty-four Hours previously. Fahr.					Computed from Observations.		Rain.		Wind.		Cloud.
	Mean Reading.	Extreme Range.	Mean. Temp. in Shade.	Mean Daily Range of Temp.	Extreme Range of Temp.	Max. Temp. in Sun's Rays.	Min. Temp. on Grass.	Mean Elastic Force of Vapour.	Mean Degree of Moisture (Saturation = 100).	Total Fall in Inches.	No. of Days on which Rain fell.	Average Daily Force in Miles for Year	Maximum Velocity in Miles in any 24 hours, and Date	Mean Amount (0 to 10).
Auckland...	30·056	1·110	59·5	12·8	46·0	147·0	32·0	0·364	71	37·790	198	213	898 on 13th May.	5·3
Previous 32 years ...	29·991	...	59·1	..	...	...	...	0·387	73	42·209	183	...		..
Wellington	29·939	1·357	56·4	11·9	34·0	141·0	21·0	0·321	72	57·546	185	226	630 on 5th & 8th Jan., & 3rd Feb.	4·5
Previous 32 years ...	29·929	...	54·8	..	...	..	...	0·334	73	51·137	159	...		
Dunedin	29·829	1·429	49·4	15·1	57·0	140·0	24·0	0·265	75	48·538	181	166	610 on 12th April	5·7
Previous 32 years ...	29·972	...	50·2	...	...	...	...	0·276	73	36·863	158	...		.

Average Temperature of Seasons compared with those of the Previous Year.

Stations.	Spring September, October, November.		Summer. December, January, February.		Autumn March, April, May.		Winter. June, July, August.	
	1895.	1896.	1895.	1896.	1895	1896.	1895.	1896.
Auckland	56·3	56·7	67·1	66·8	59·9	61·3	50·6	53·1
Wellington	54·2	53·4	63·9	62·4	55·2	56·5	47·1	49·2
Dunedin	49·9	48·8	59·4	57·8	49·7	48·8	41·5	42·4

REMARKS ON THE WEATHER DURING 1896.

January.—Generally fine in North and over centre, with strong S.W. and N.W. winds, and thunder early part. In South showery and changeable.

February.—In extreme North very fine; over centre heavy rain early and latter part of month; winds N.W., and frequently strong. In South fine, with light winds.

March.—Fine in North; over centre heavy rain during latter part, and strong N.W. and S.E. winds; in South changeable weather.

April.—Heavy rain in North and centre, with prevailing S.W. and N.W. winds; with thunder over centre; in South showery and unsettled.

May.—Generally showery weather throughout, but not a heavy total rainfall; moderate winds.

June.—Fine early part of month in North, but showery towards end; over centre heavy rain generally; moderate winds. In South fine, with light showers.

July.—Very wet weather throughout; prevailing S.W. and N.W. winds, and often strong; thunder in early part of month in North.

August.—Generally showery during this month, and moderate winds; occasional snow and cold weather in South.

September.—Wet early and latter part of month in North and over centre; prevailing N.W. and S.W. winds, and frequently strong; snow and hail towards end of month. In South fine weather.

October.—Fine in North, but strong S.W. winds prevailed; over centre showery, but fine at intervals, and strong N.W. winds. In South showery, with hail towards end, and prevailing S.W. winds.

November.—Generally fine weather in North and over centre, but strong S.W. winds in North; snow (on hills) and hail in early part over centre. In South cold wet weather, with snow, early part of month; winds S.W.

December.—Fine weather throughout, with moderate winds.

EARTHQUAKES reported in NEW ZEALAND during 1896.

PLACE	Jan.	Feb	Mar	April	May	June	July.	Aug.	Sept	Oct	Nov	Dec	Total
Taupo ..	..	..	..	..	..	..	..	..	..	..	18	..	1
Napier ..	..	..	..	..	..	28*	..	..	..	..	..	..	1
New Plymouth	21*	..	..	..	9, 25	..	..	29	..	27	..	..	5
Woodville ..	..	..	..	25*	..	..	..	..	..	..	..	..	1
Mauriceville..	..	..	..	25*	..	..	..	..	..	..	..	..	1
Levin ..	..	..	..	24, 25	..	..	..	..	..	..	..	..	2
Wellington ..	16	..	..	25	29	..	..	14, 15, 24	..	19	27	..	8
Blenheim ..	..	..	..	..	..	..	..	..	..	..	..	7*	1
Christchurch .	..	..	..	..	..	..	..	20, 23*	..	..	..	..	2
Amberley ..	..	..	..	..	..	..	..	20*	..	..	.	..	1
Stephens Is.	..	..	..	..	..	..	..	..	..	..	..	7*	1

NOTE.—The figures denote the day of the month on which one or more shocks were felt. Those with the asterisk affixed were described as *smart*. The remainder were only slight tremors, and no doubt escaped record at most stations, there being no instrumental means employed for their detection. These tables are therefore not reliable as far as indicating the geographical distribution of the shocks

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1872

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1873

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1874.

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1875

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1876

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1877

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1878.

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1883.

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1885.

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1888.

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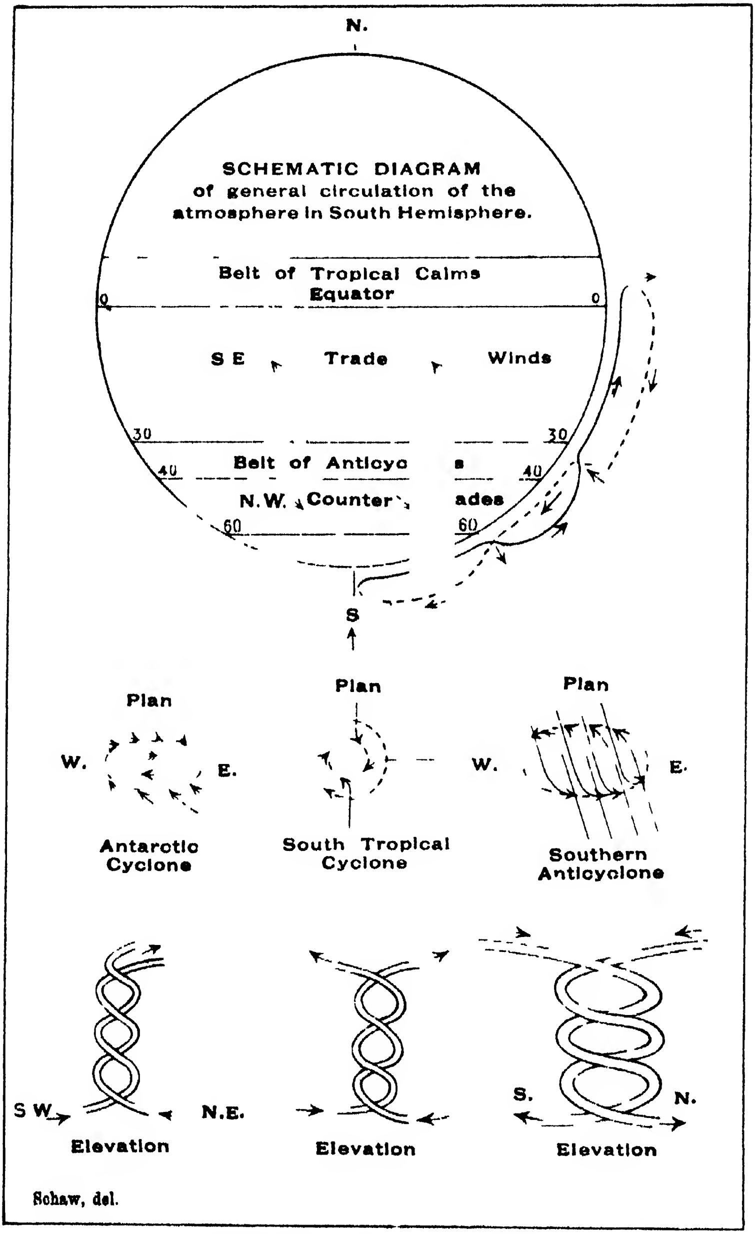
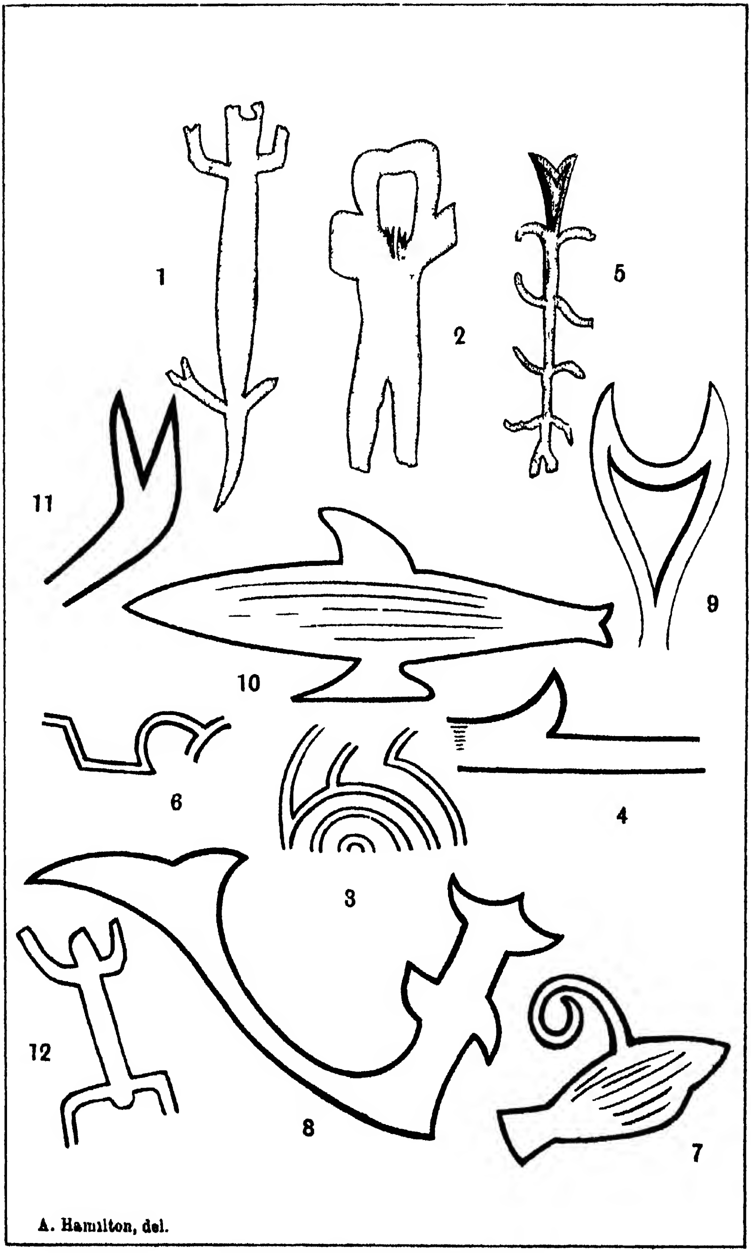


SCHEMATIC DIAGRAMS

TO ILLUSTRATE SUGGESTED ORIGINS.



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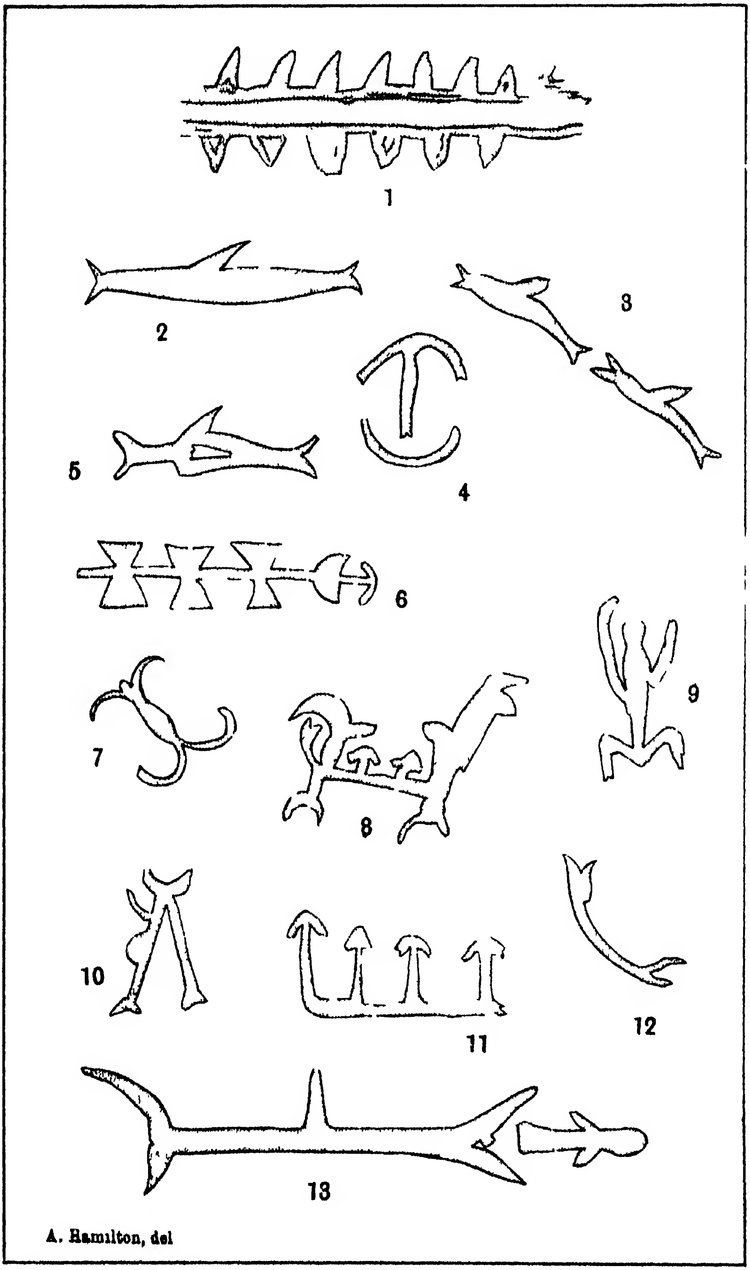

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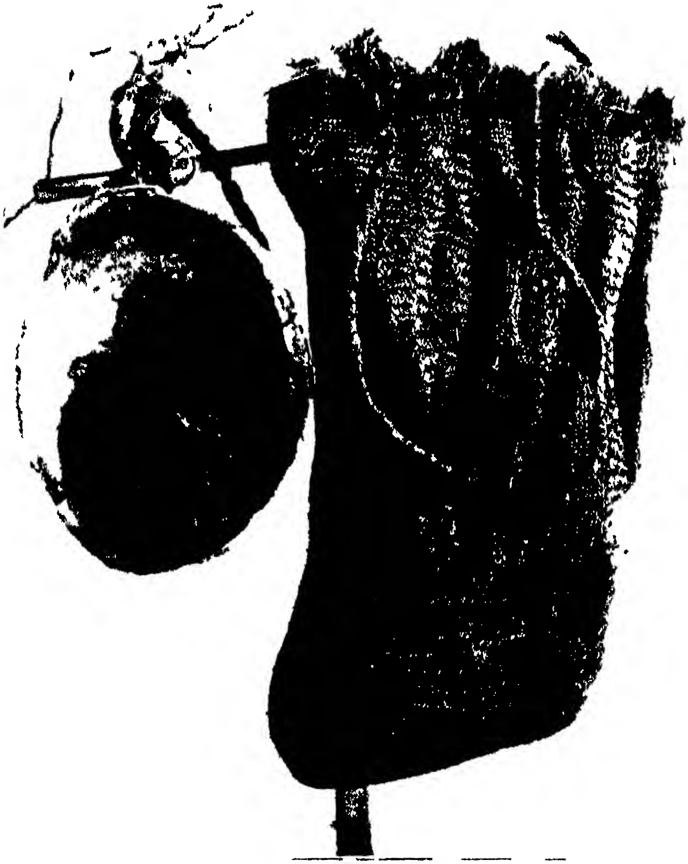

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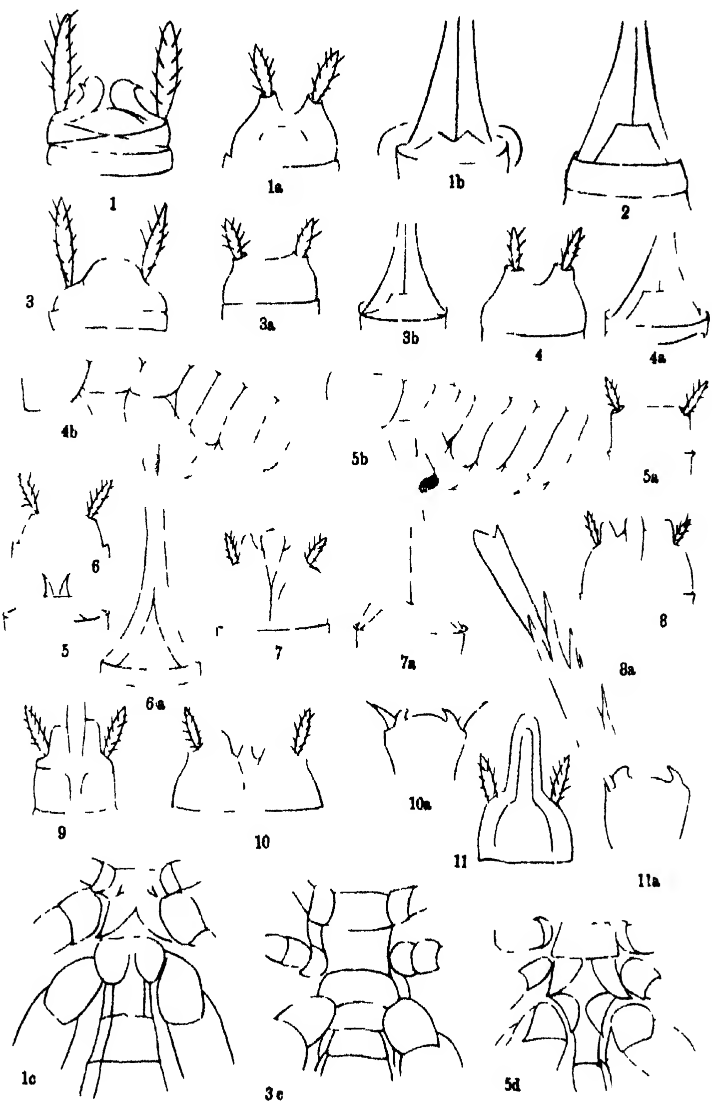

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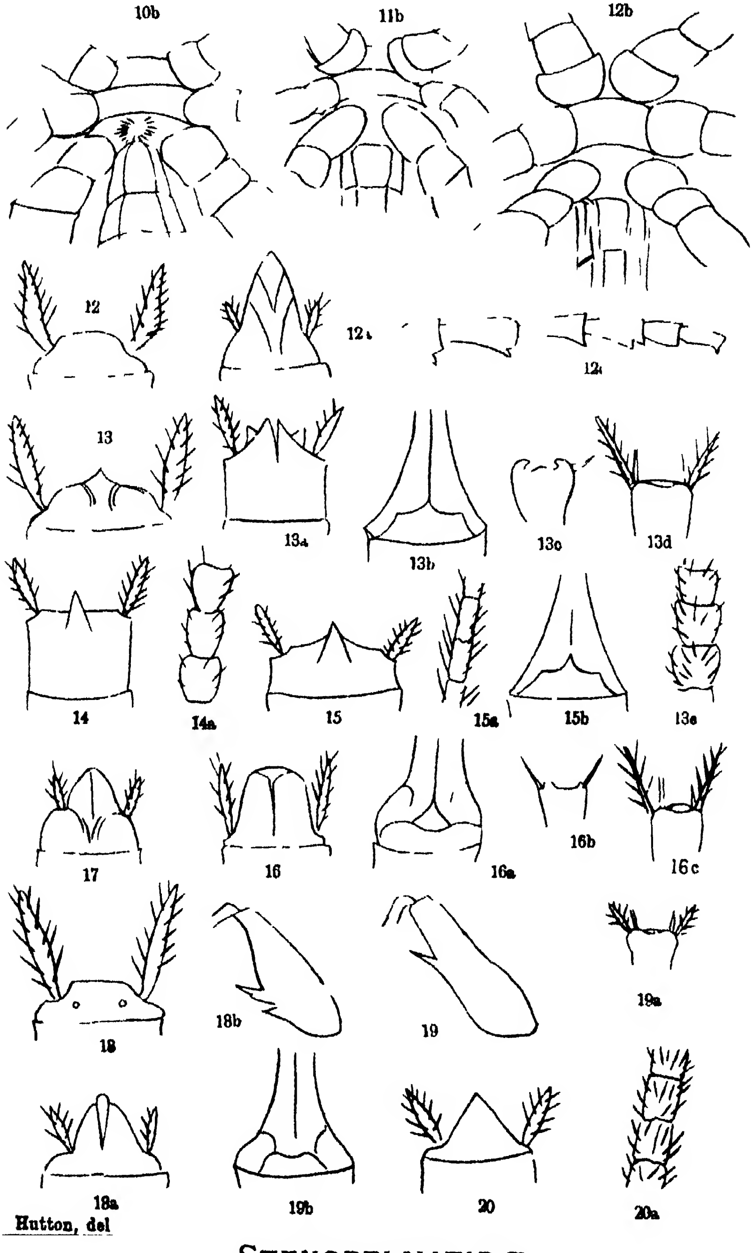

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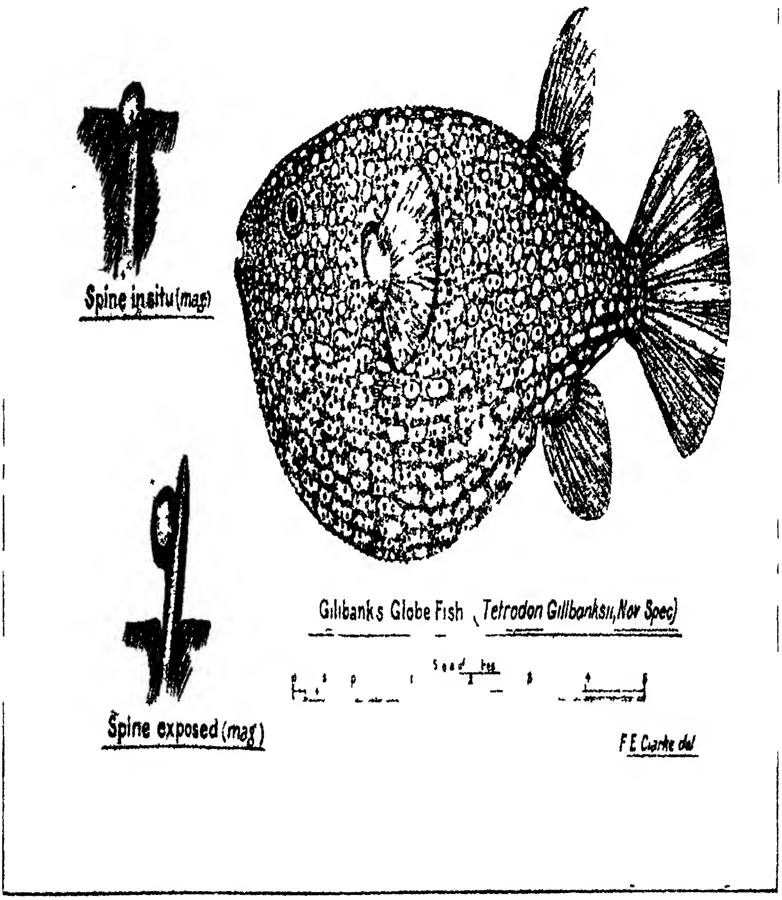

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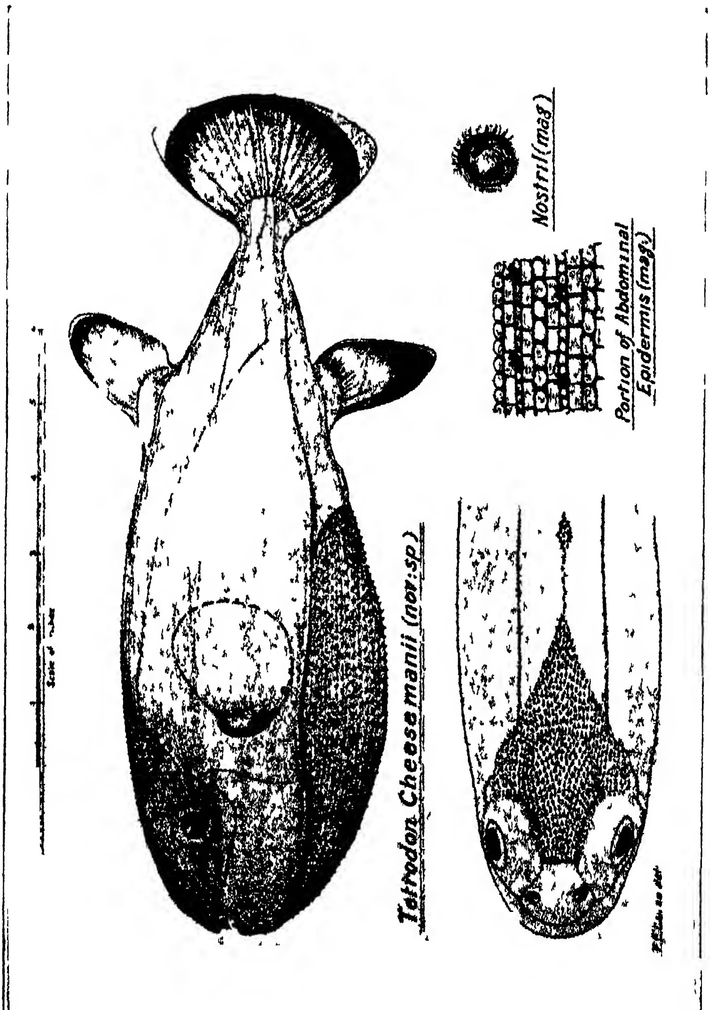

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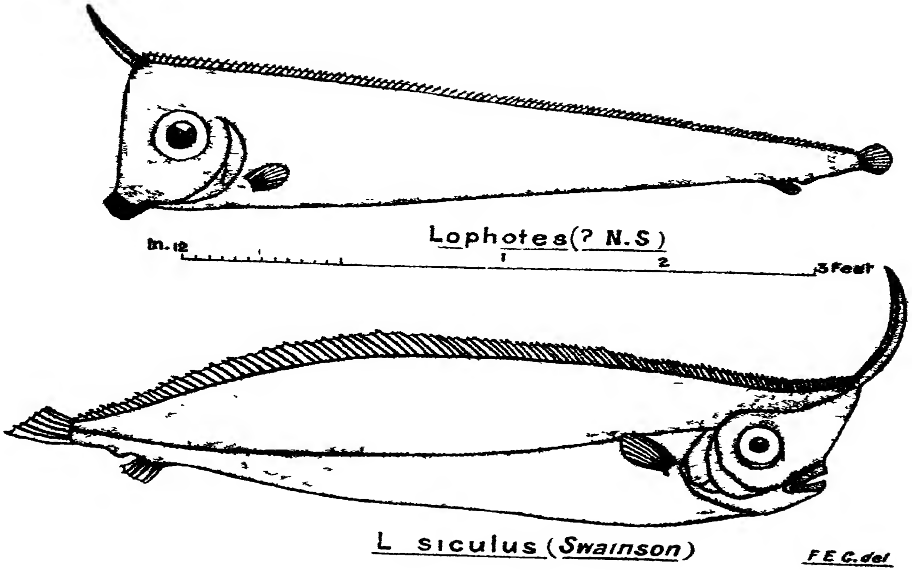

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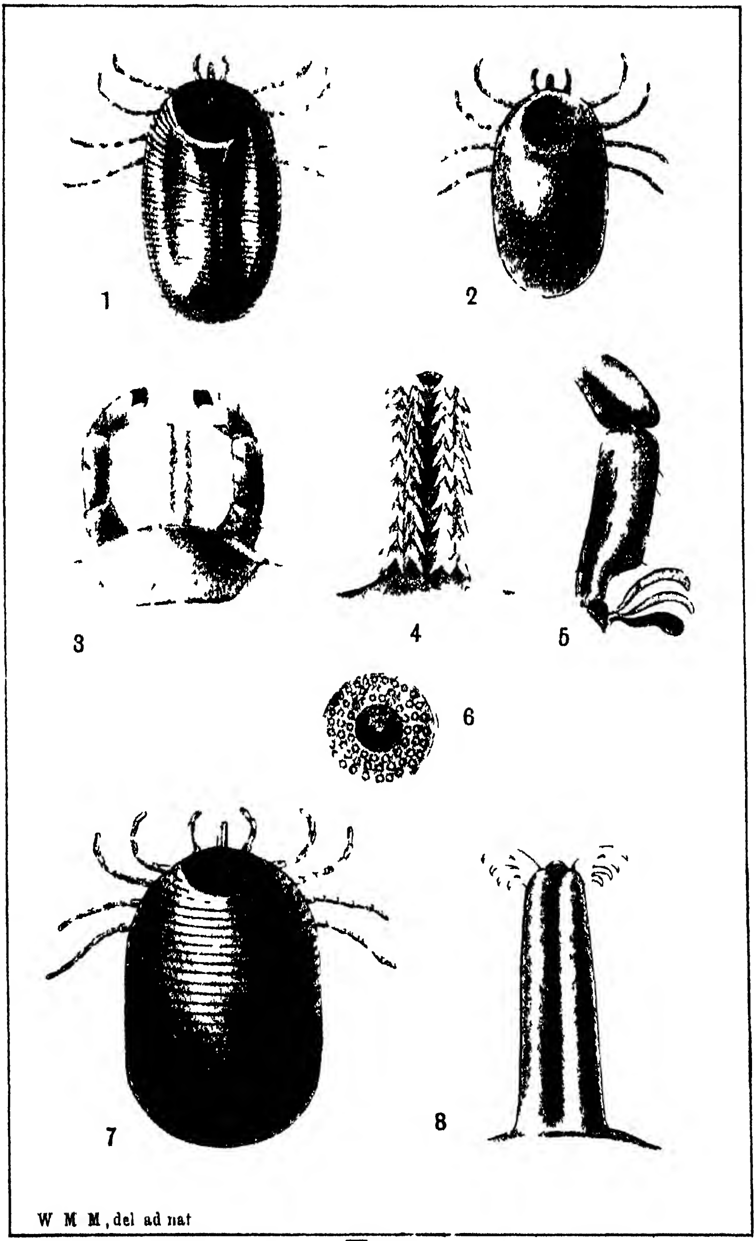

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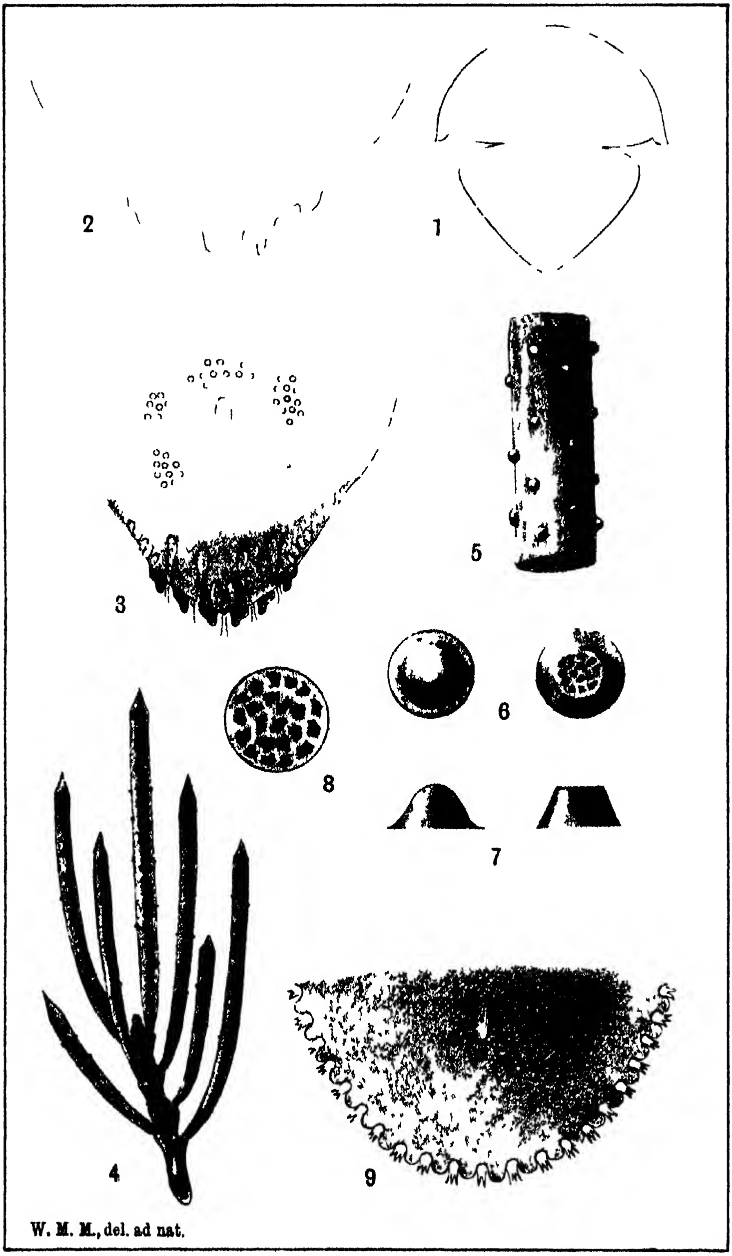

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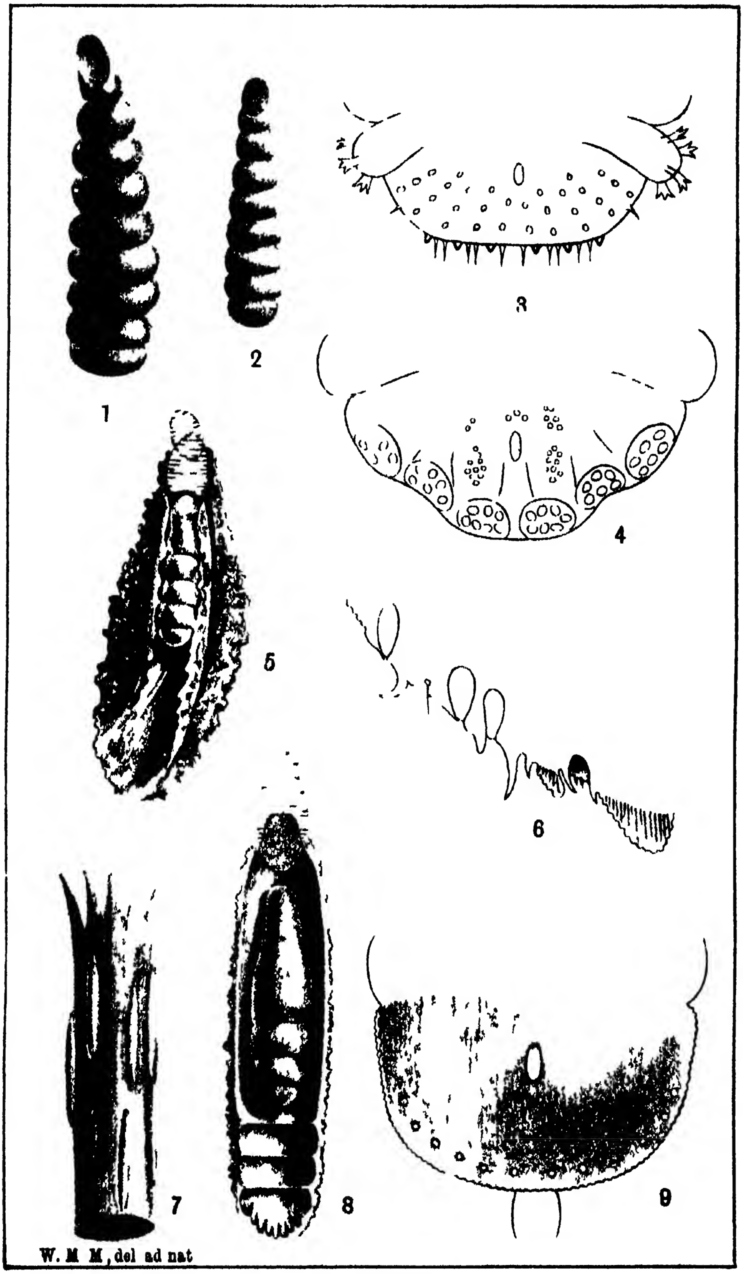

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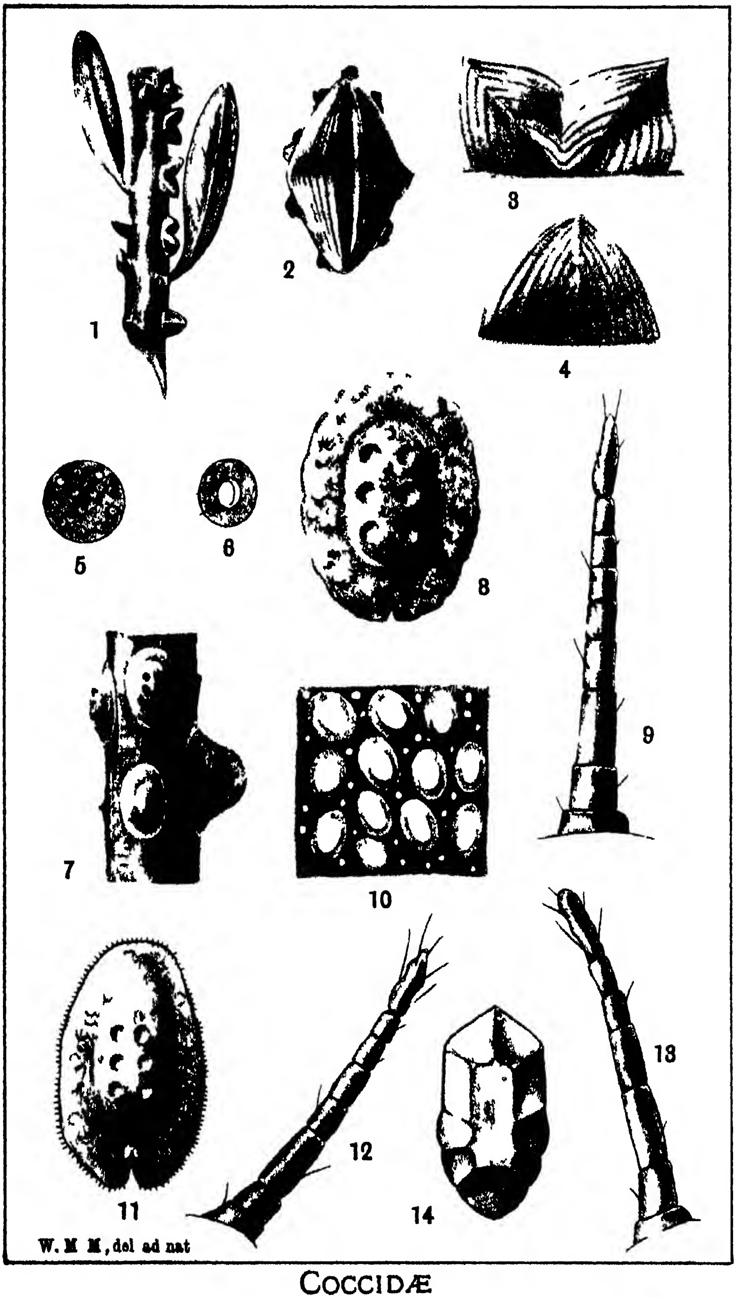

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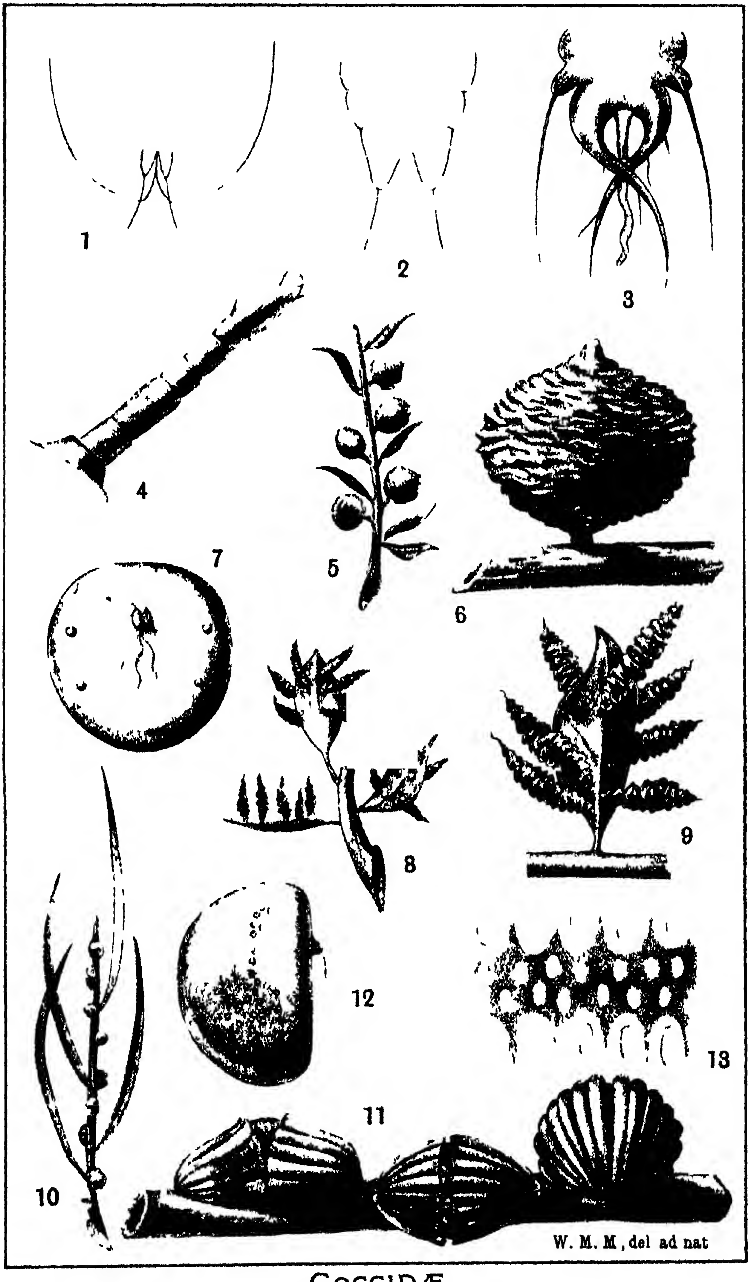

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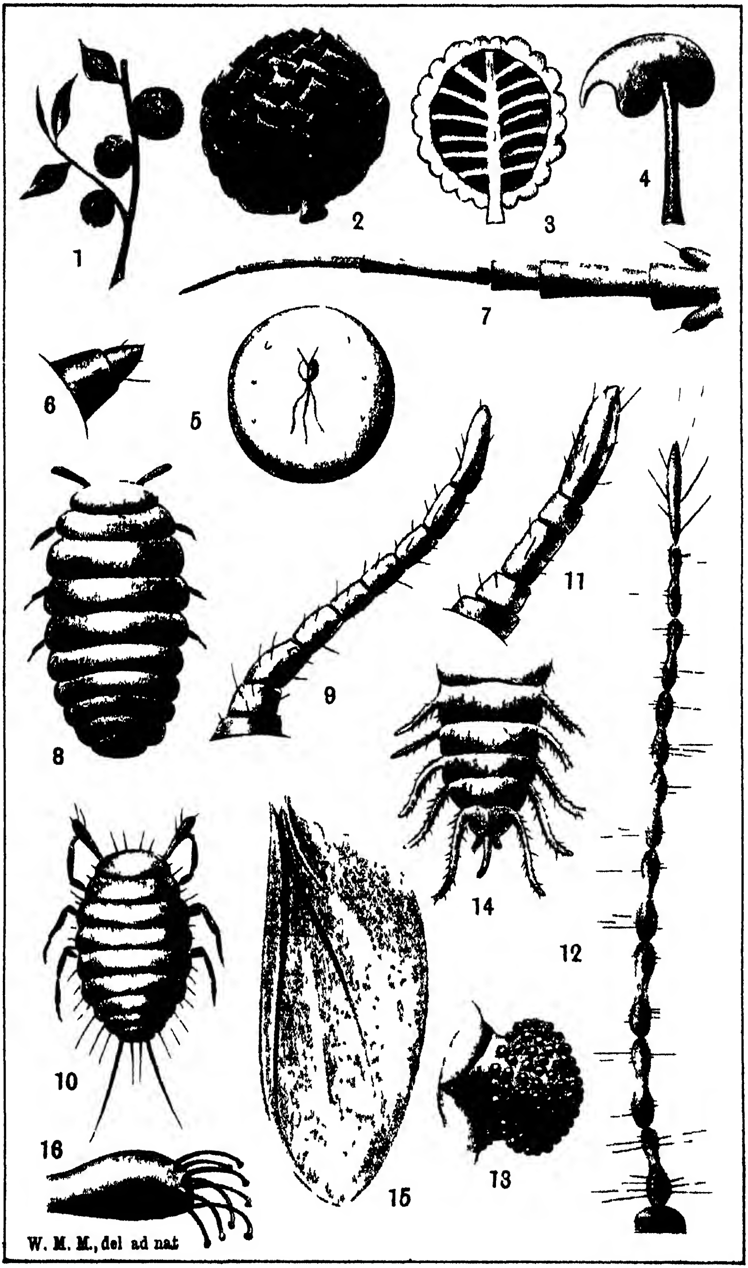

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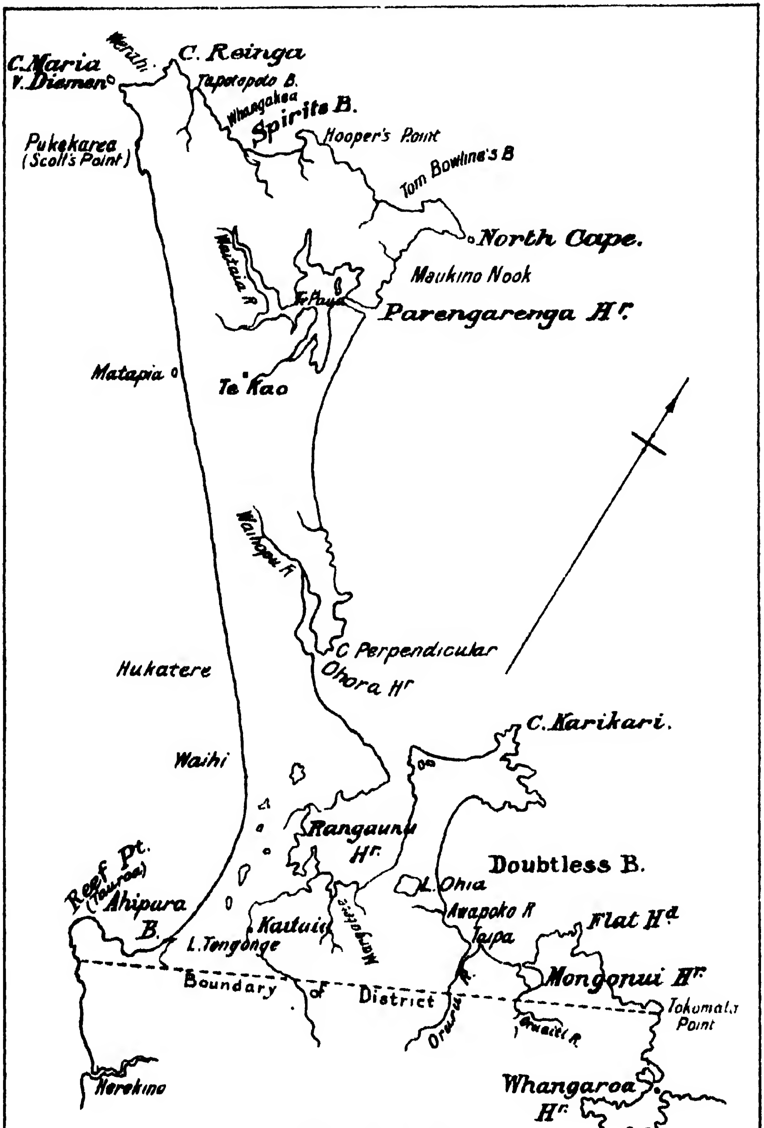

SKETCH MAP

to accompany a Paper by Mr. Cheeseman

—— on the Flora of the ——

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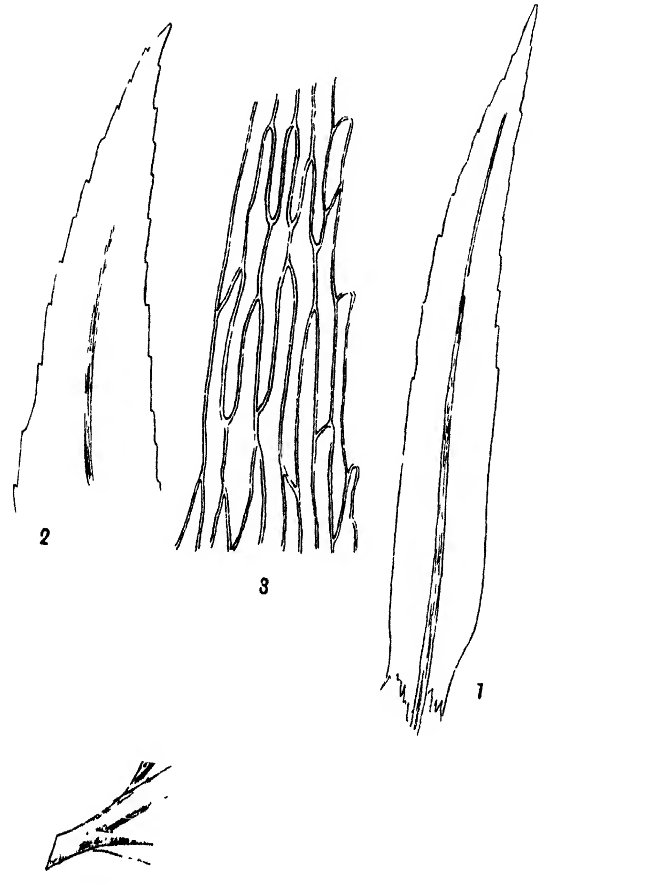

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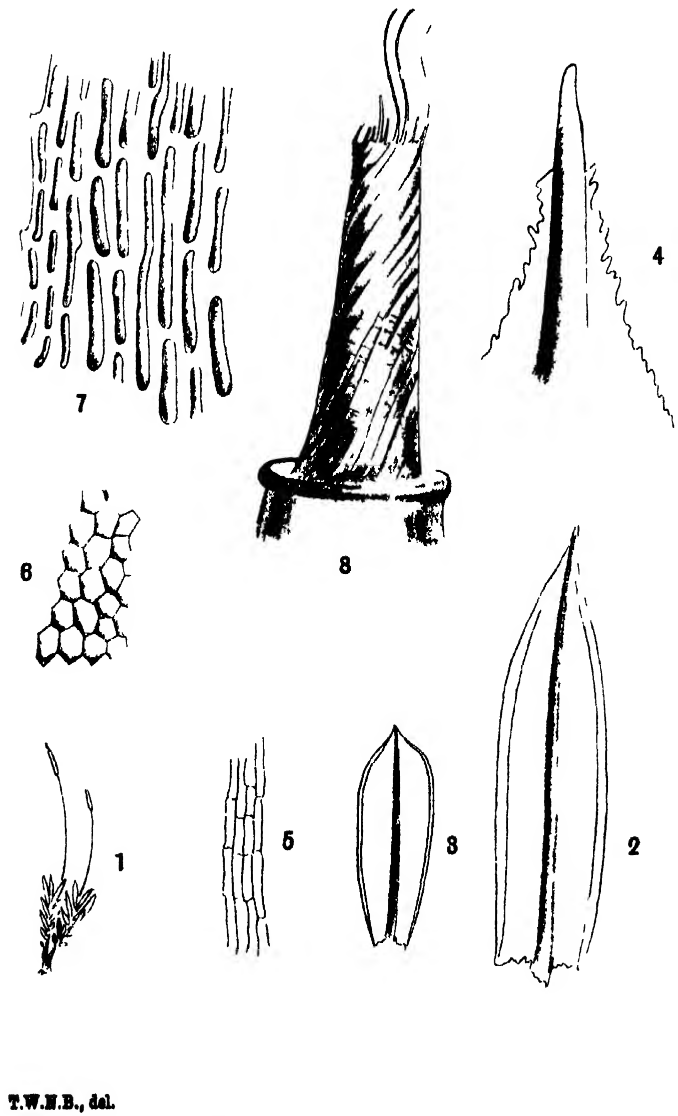
MNIOBRYUM TASMANICUM.



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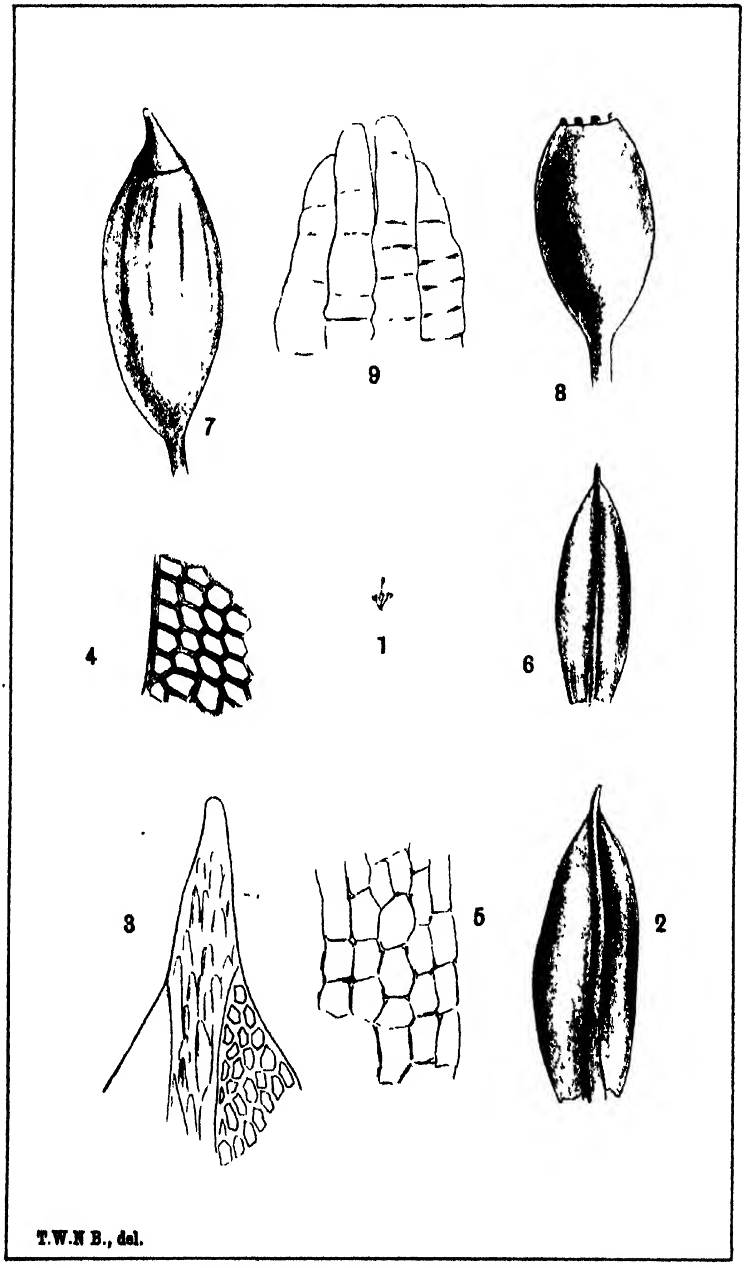

ZYGODON MUCRONATUS.

DELESSERIA.
(Lune)

Fig. 1

Fig. 2

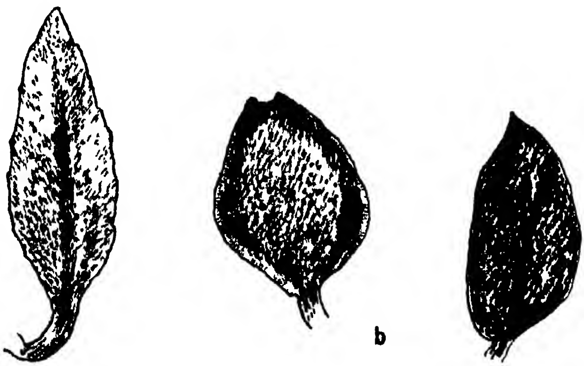

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Fig. 8

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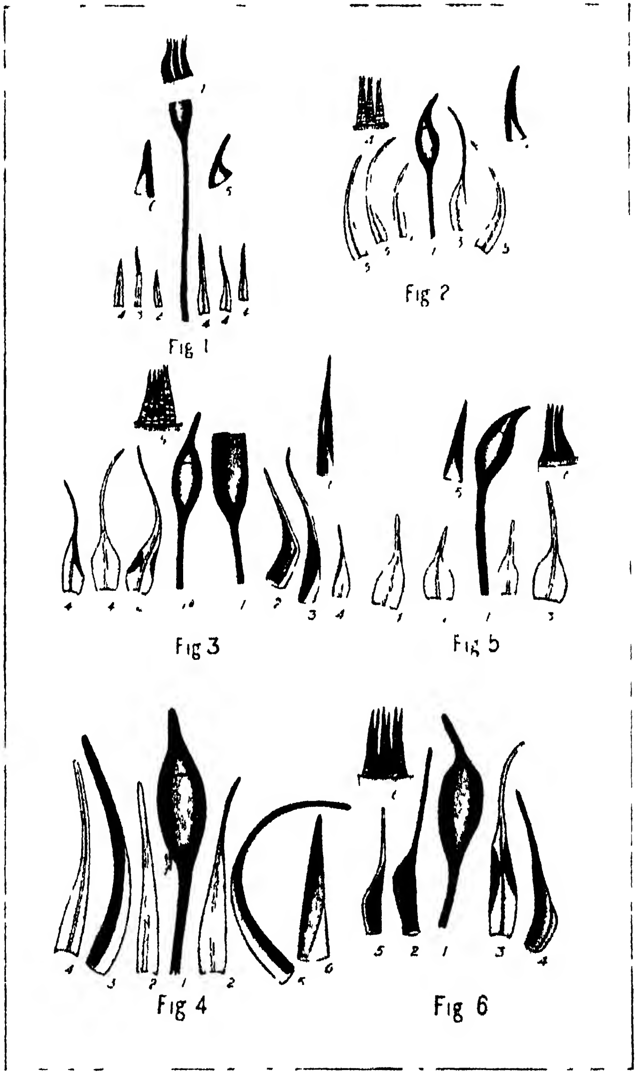
DELESSERIA.



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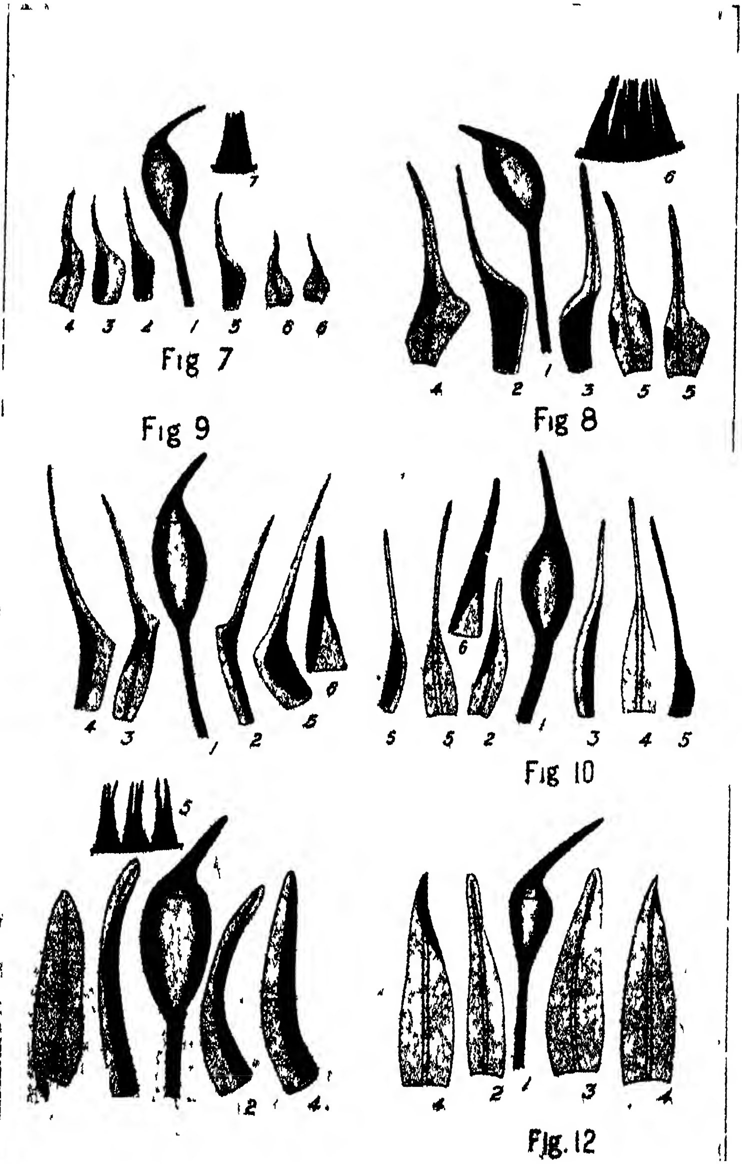

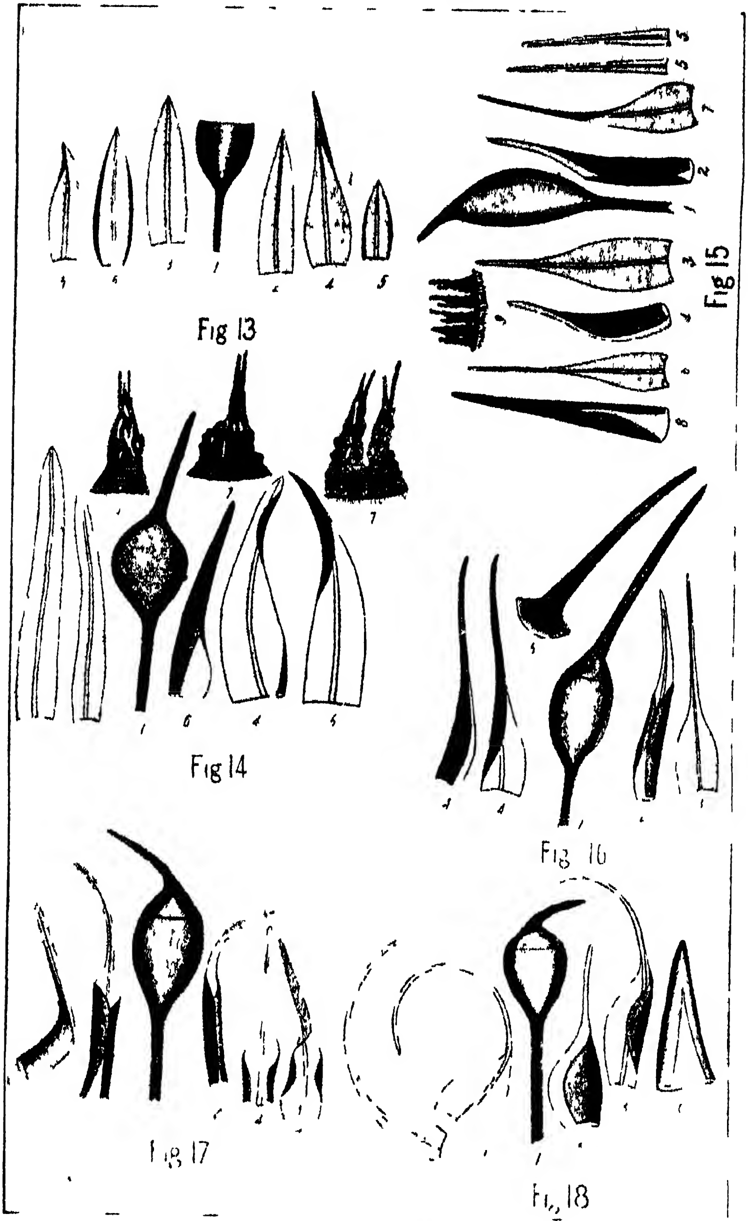

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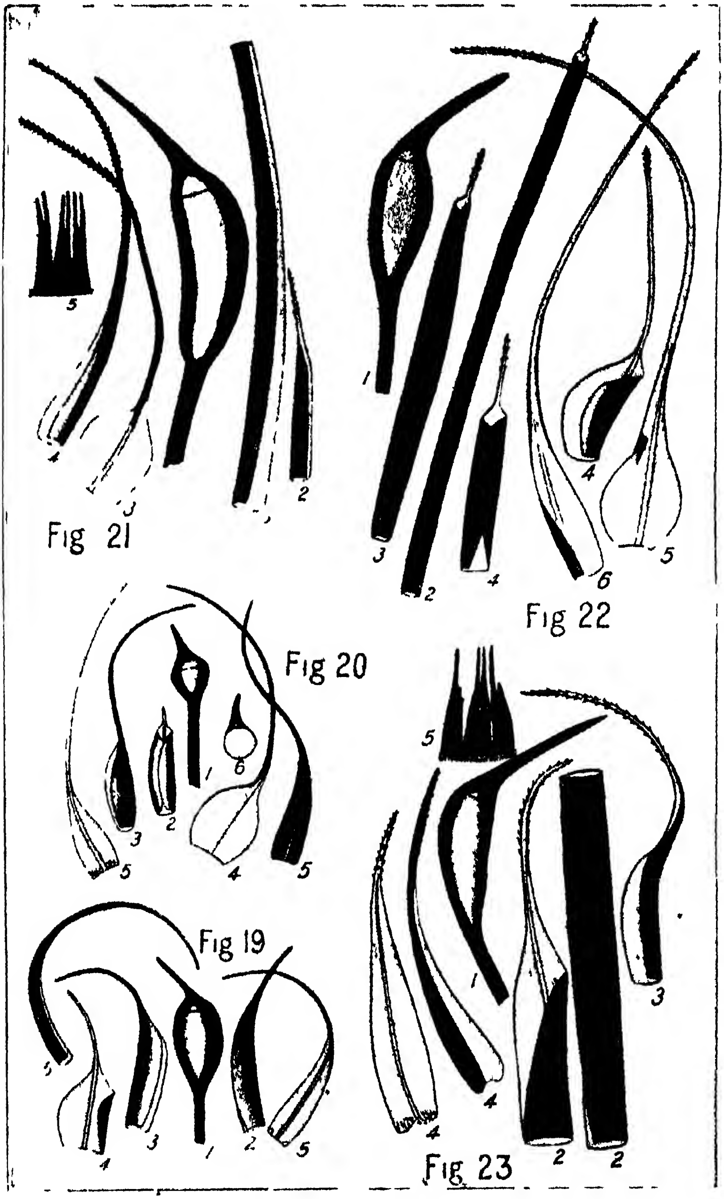

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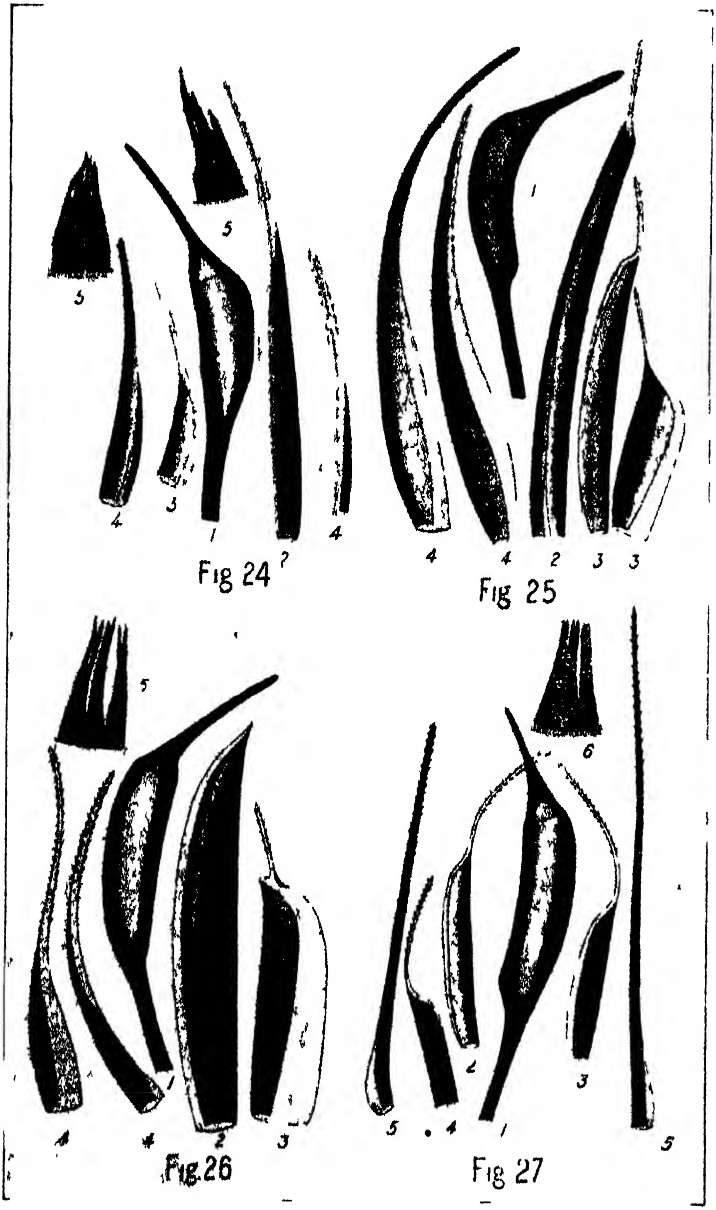

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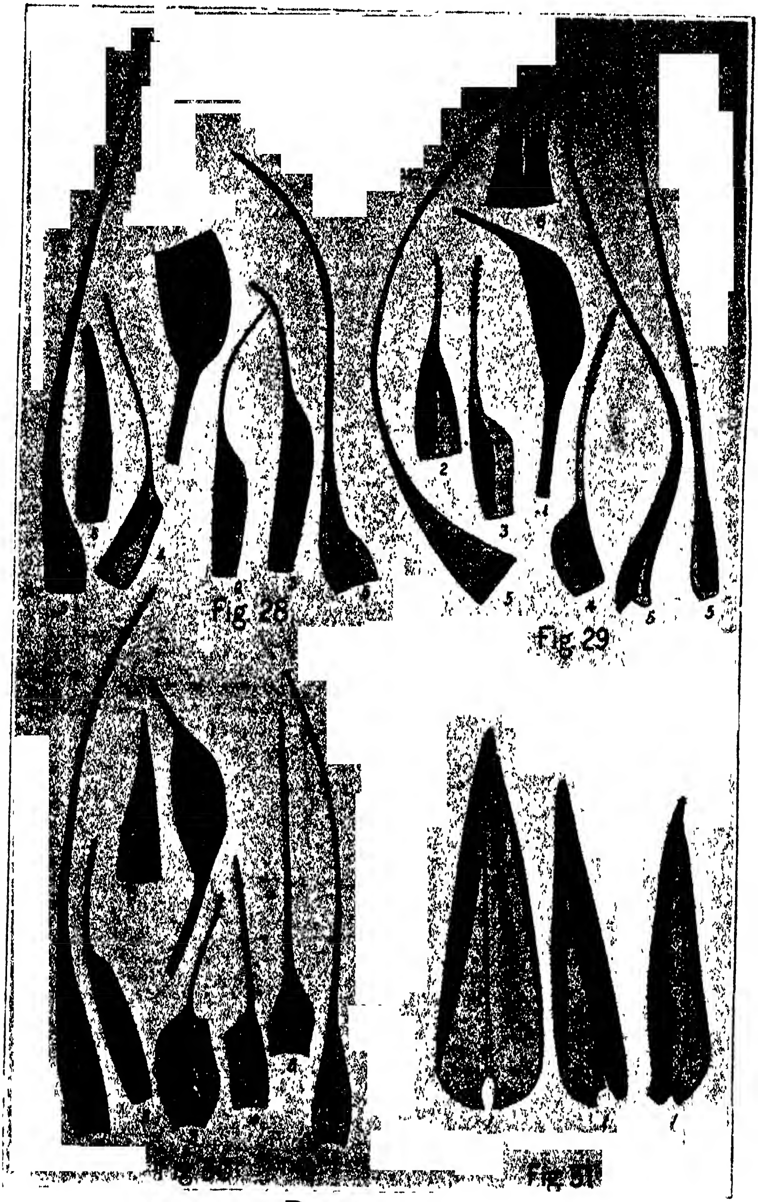

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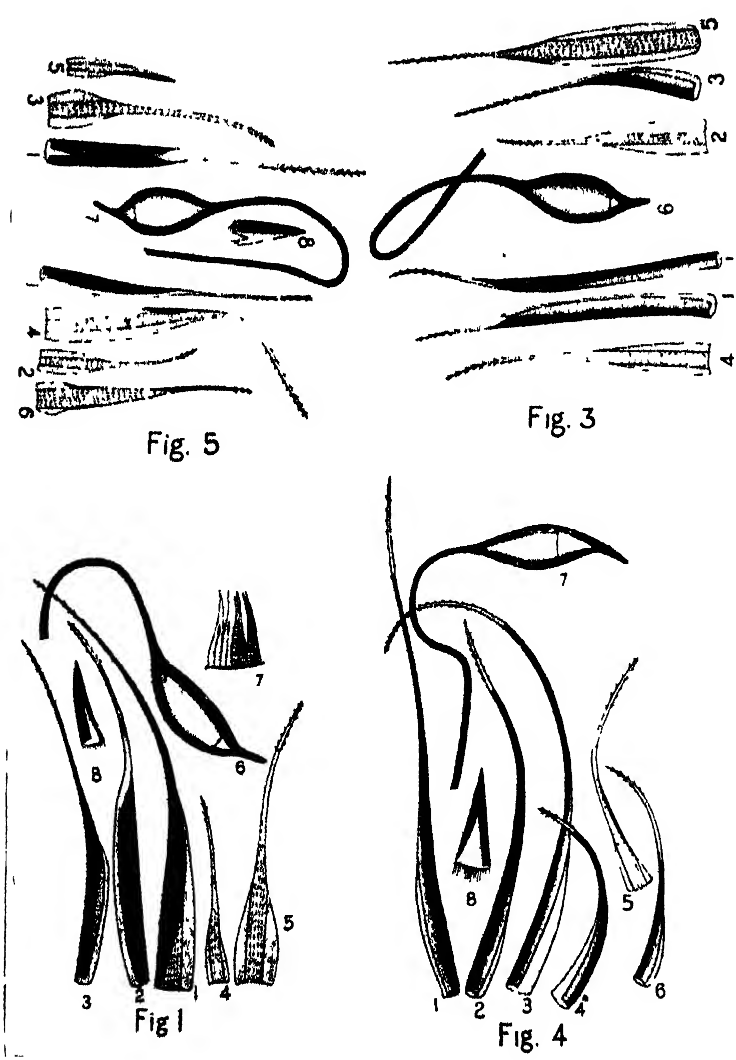

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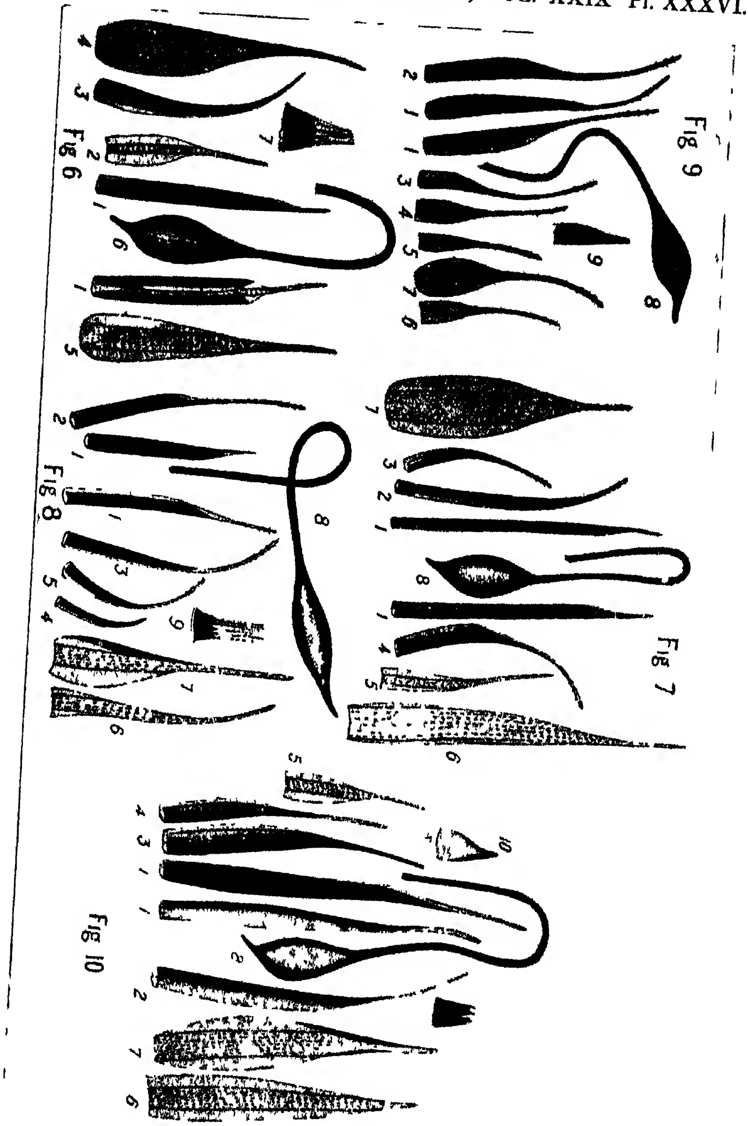

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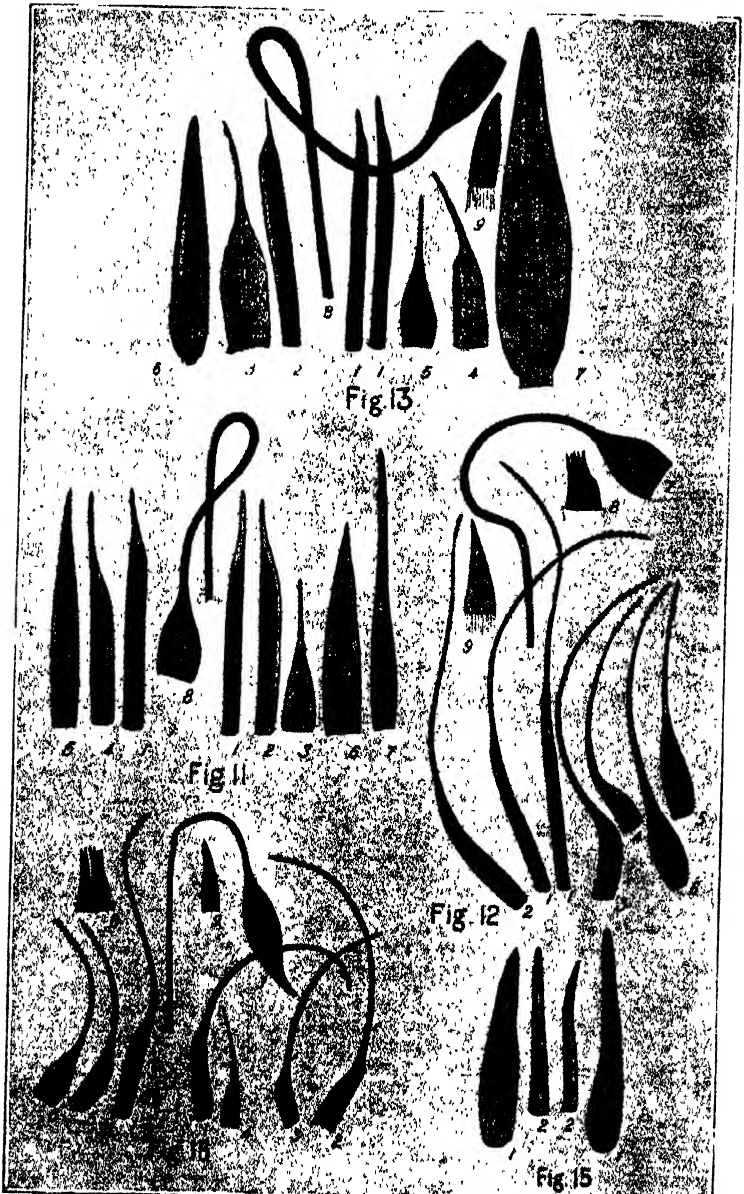

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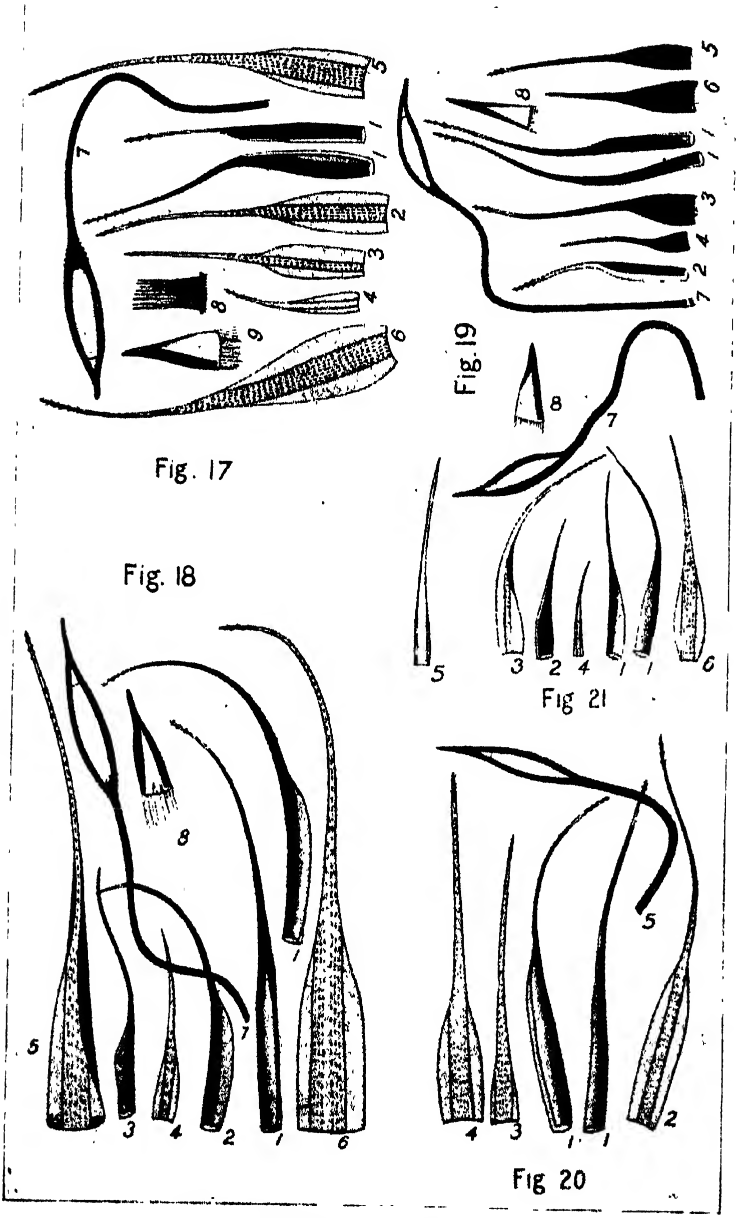

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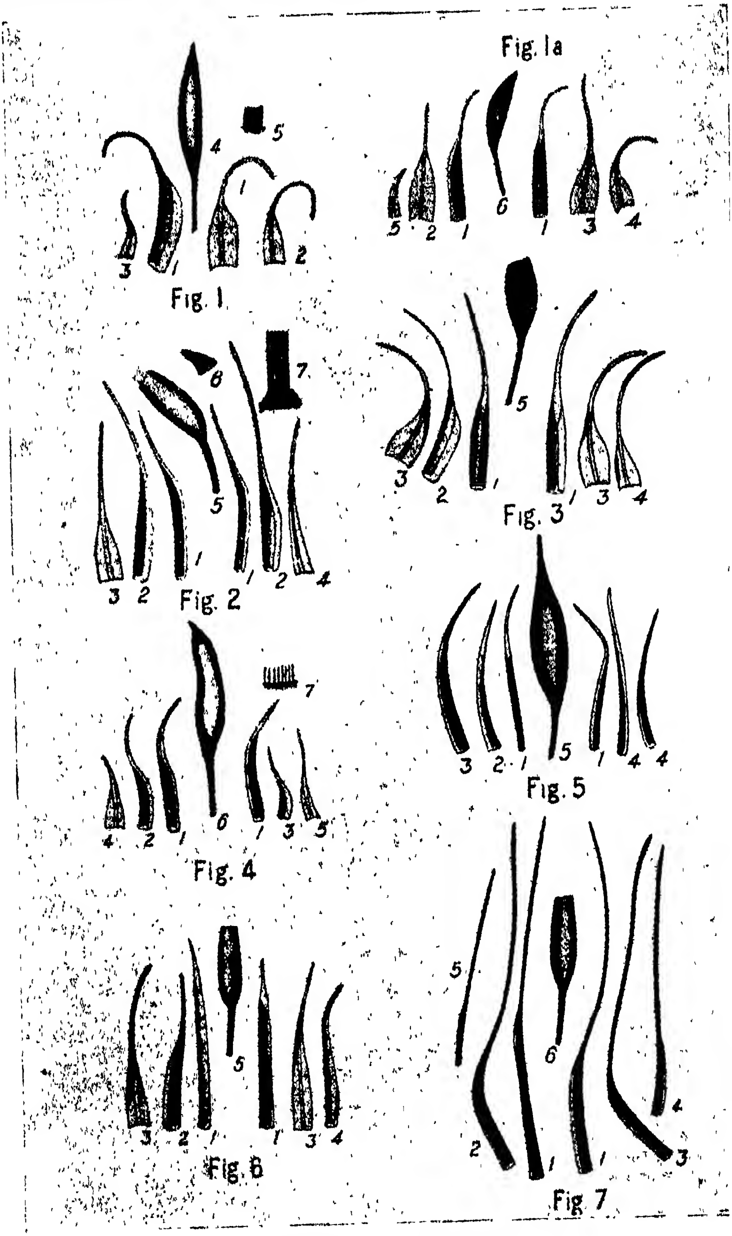

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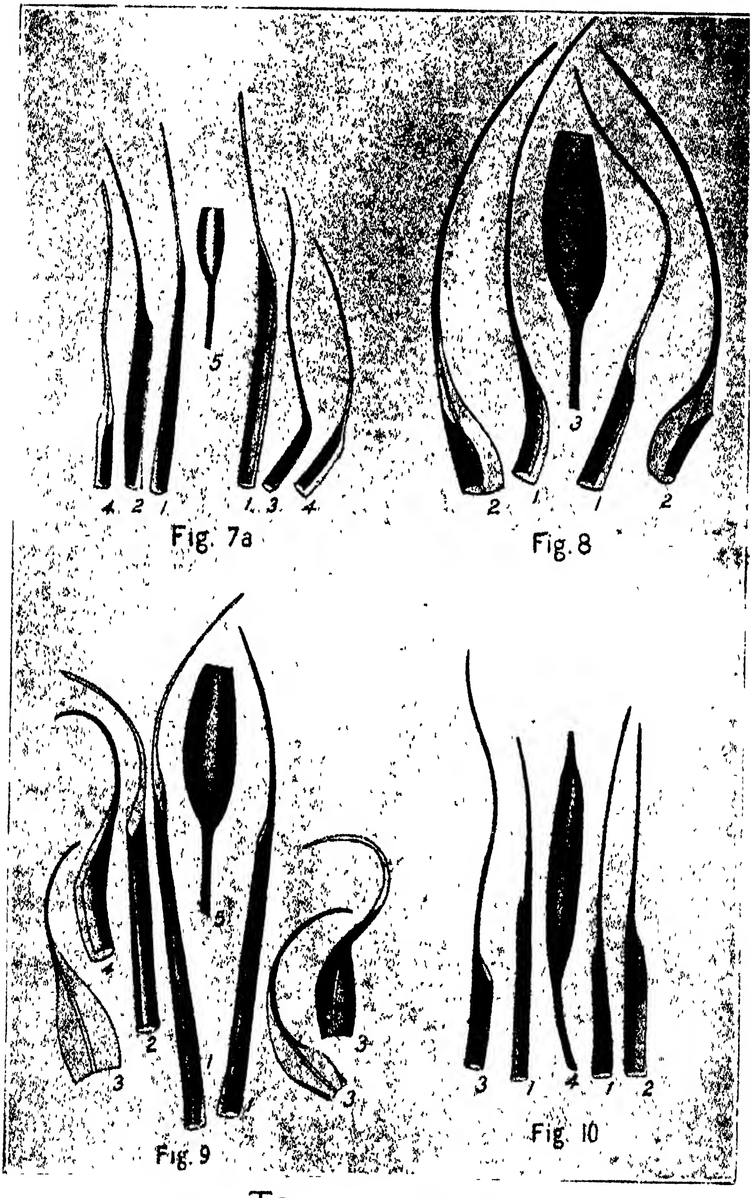

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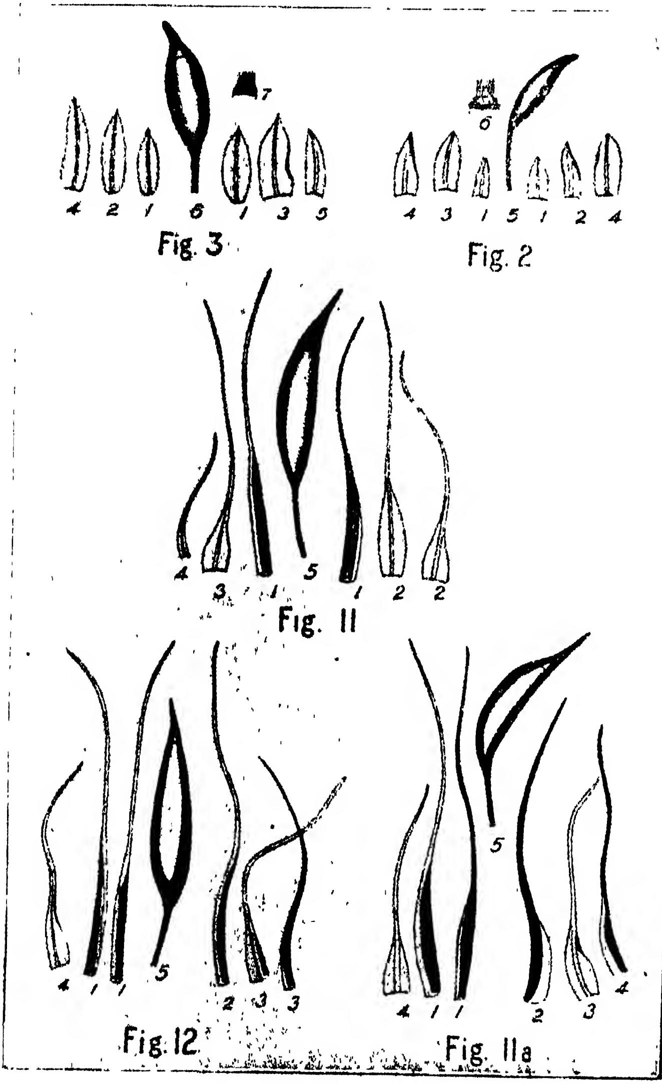

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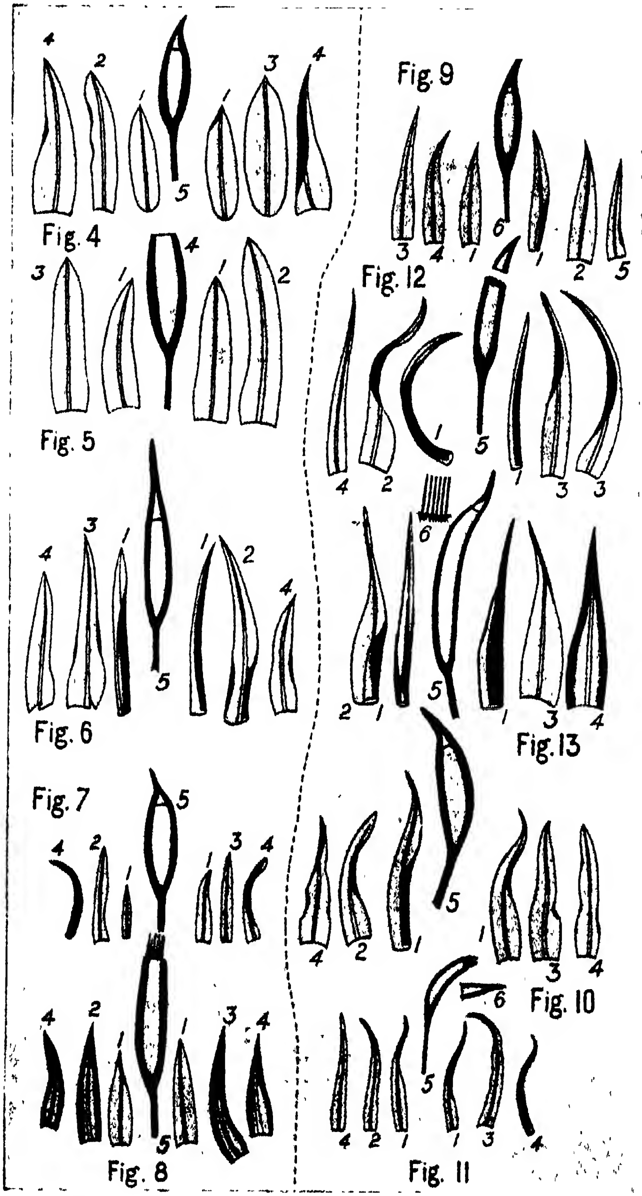

TRICHOSTOMUM.
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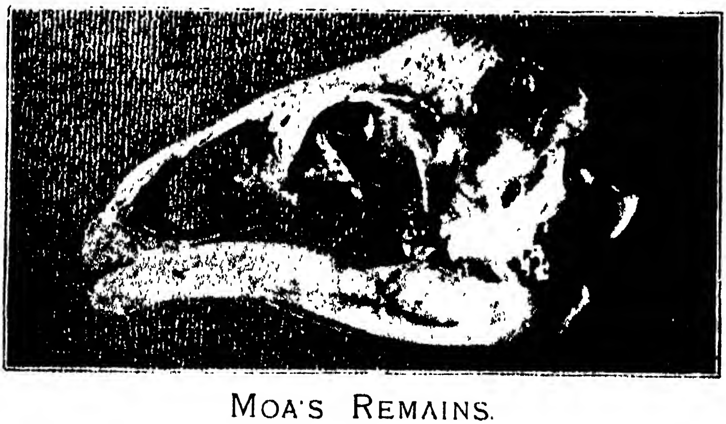
PARATROPHIS HETEROPHYLLA.
(Kirk.)

MOA'S REMAINS.
(Hutton)

MOA'S REMAINS
(Hutton.)



MOA'S REMAINS.
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(Hutton.)